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Physical and Chemical Characterization of Coal

United Technologies Research Center
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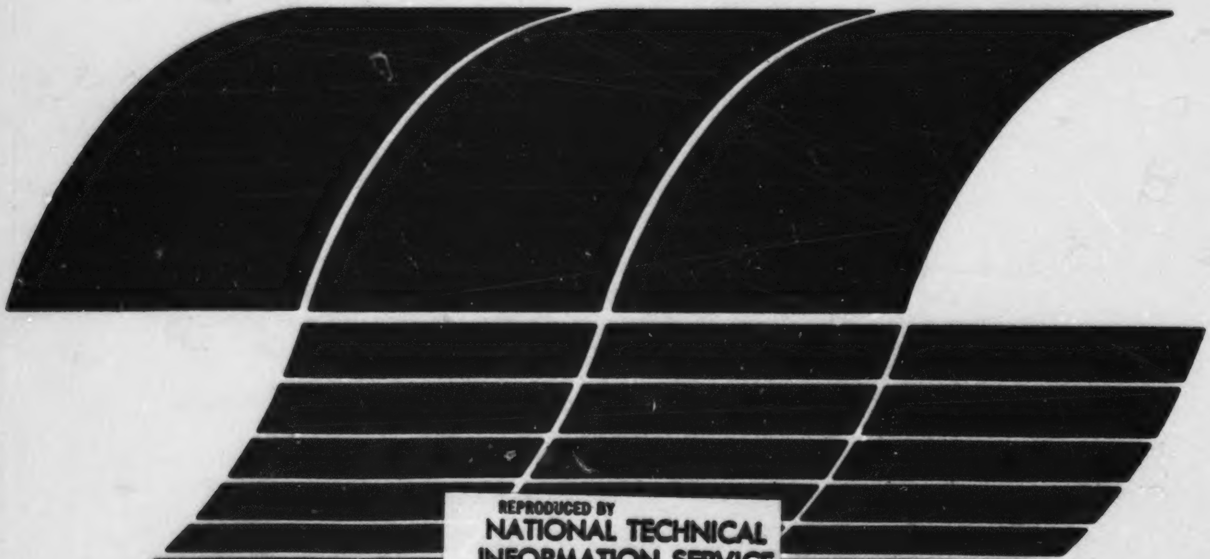

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16. ABSTRACT

The report describes an automated scanning electron microprobe method of analyzing sulfur forms and mineral matter in coal. The microprobe is used to measure the spatial distribution of a number of elements (including Fe, S, Si, Al, Ca, and K) on a scale where individual grains can be observed. These data are then analyzed to extract the following information: organic sulfur concentration; mineral sulfur concentration; total sulfur concentration; major mineral concentrations, including Al_2O_3, SiO_2, K_2O, and $CaCO_3$; and stoichiometry of iron sulfide, FeS_x. The procedure is fully automated: all of the above information is obtained on a 200 mg coal sample in less than 15 minutes. Sulfur forms and total sulfur were reproducible to within 0.1 wt %. In addition, estimates of the pyrite particle size for two coals were obtained from the spatial distribution of the Fe and S data, and these estimates are compared with the results of a washability study. A commercial elemental analyzer, evaluated for use in determining nitrogen in coal, gave results that were reproducible and accurate to within 3%.

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Coal	Sulfur	Stationary Sources	08G	07B
Properties	Minerals	Scanning Electron Microprobe	14G	
Analyzing	Stoichiometry	Characterization	14B	07D
Automatic Control	Nitrogen			
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Physical and Chemical Characterization of Coal

by

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FOREWORD

Under Contract 68-02-3116 sponsored by the Environmental Protection Agency, the United Technologies Research Center (UTRC) is conducting a program to develop several new automated coal analysis procedures employing a scanning electron microprobe. The program is directed at the growing need for more accurate and lower cost coal characterization methods precipitated by environmental considerations and increased emphasis on coal conversion. The program is divided into two main tasks. Under Task I, the new techniques of sample preparation, data aquisitions, and data analysis are developed. In Task II, the procedures developed in Task I are evaluated for speed, accuracy and precision.

ABSTRACT

The MASC (Microprobe Analysis of in Sulfur Coal) procedure, which uses a statistical analysis of the spatial distribution of sulfur and iron in coal to determine the forms of sulfur (organic, pyritic, and sulfatic) has been refined to account for the effects of mineral particle size, and the presence of iron oxides, in order to obtain better quantitative estimates for the mineral sulfur forms. These refinements include grinding the coal fine enough that the particle size effects are eliminated, pressing the resulting powder to provide a uniform smooth pellet, and adding the analysis of additional elements to allow the determination of the clay constituents. Using the procedures developed in this program it is possible to obtain measurements for the sulfur forms and total sulfur which are reproducible to 0.1 wt. % and are within 0.5 wt. % of the ASTM measurements for the forms and 0.25 wt. % for the total sulfur. In addition, the pyrite stoichiometry is obtained (x in the formula FeS_x, reproducible to 5%). Also obtained from the analysis is the determination of the major inorganics (Al, Si, Ca, Mg, K, Ti), accurate and reproducible to 5% of the measurement or 0.2 wt. %, whichever is greater.

Estimates of the pyrite particle size for two coals are obtained from the spatial distribution of iron and sulfur in samples which were ground to 40 mesh top size, and these results are compared with washability studies for two coals.

The time required for all of these measurements is less than 15 minutes, and the procedure uses only a 200 mg sample of the coal.

In addition, the use of a commercial elemental analysis is evaluated for use in the determination of nitrogen in coal, and found to give results accurate and reproducible to within 3% of the measurement.

Physical and Chemical Characterization of Coal

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SUMMARY

Under Contract 68-02-3116 sponsored by the Environmental Protection Agency, the United Technologies Research Center (UTRC) is conducting a program to develop several new automated coal analysis procedures employing a scanning electron microprobe. The program is directed at the growing need for more accurate and lower cost coal characterization methods precipitated by environmental considerations and increased emphasis on coal conversion. The program is divided into two main tasks. Under Task I, the new techniques of sample preparation, data acquisitions, and data analysis are developed. In Task II, the procedures developed in Task I are evaluated for speed, accuracy and precision.

Limitations on the acceptable levels for SO_2 and NO_x emissions from power plants make the direct burning of 80 percent of our eastern and midwestern coals (those most accessible to the majority of power plants) unlawful. Future restrictions on other emissions from major and minor mineral components may further restrict the use of coal. The development and implementation of coal cleaning procedures requires extensive characterization of feed coals and the products of the cleaning process, but many of the methods for characterization are cumbersome and inaccurate. New methods for the analysis of sulfur forms and the determination of pyrite particle size distribution are needed. The ASTM sulfur forms analysis (Ref. 1) is time consuming and costly. In addition, recent studies using the Mossbauer technique have shown up to 50 percent error in the pyrite determination in some coals (Ref. 2, 3). The organic sulfur which is determined by difference suffers corresponding errors. Development of coal analysis procedures which could improve accuracy and cut cost and time would be highly desirable. In addition, the development of rapid and inexpensive methods to determine the size distribution of pyrite and other minerals would be valuable for predicting the effectiveness of mechanical cleaning procedures (Ref. 4).

Analysis of the organic sulfur concentration, S(O), in coal is difficult because the organic material is intimately mixed with inorganic compounds of sulfur. The standard ASTM method (Ref. 1) which calls for the determination of S(O) by subtracting the sulfate and sulfide contribution from the total sulfur is complicated, and often inaccurate. The MASC (Microprobe Analyis of Sulfur and Coal) method for the direct determination of S(O) eliminates these deficiencies and is applicable to coal chars as well. In addition, the elemental ratio X of iron sulfide compounds, FeS_x, is also obtained. By including other elements in the analysis, the MASC procedure

also determines the major mineral concentrations as well. Other advantages of the method include: the ability to use small samples, low cost, speed (a complete analysis is currently being performed in approximately 10 minutes) and the option of repeating results since the method is nondestructive.

In brief, the method is based on the differences in the spatial distribution of mineral sulfur (clustered distribution) and organic sulfur (relatively uniform distribution). The method uses a scanning electron microscope to measure the spatial distributions of a number of elements of interest in addition to iron and sulfur. The x-ray intensities for a large number of subsamples are measured. Considering just the iron and sulfur intensities as a first approximation if we plot these intensities in a scatter plot of iron versus sulfur, it will be seen that the data lie along a line. The intercept of this line on the sulfur axis represents sulfur which has no iron, i.e., non-pyrite sulfur; and the line has a slope which is indicative of the stoichiometry of the pyrite. In addition, the average of the iron data represents the amount of pyrite present. In this study, we have measured the spatial distributions for five elements (S, Fe, Si, Al, Ca) in most cases. These additional elements are needed to correct the first approximation results from the iron and sulfur alone.

By analyzing the correlations in these spatial distributions we extract the following information:

1. Organic sulfur - within 0.5 wt. % of ASTM measurements, reproducible to 0.1%.

2. Pyrite sulfur - within 0.5 wt. % of ASTM, reproducible to 0.1%.

3. Pyrite stoichiometry - reproducible to ± 5%.

4. Calcium sulfate - one sample was observed, accuracy not known.

5. Total sulfur - by adding the forms, a value within 0.25 weight percent of ASTM measurements, reproducible to 0.1%.

6. Major inorganics including Si, Al, Fe, Ca, K, Mg, and Ti - values for total major minerals were obtained by adding up these constituents which were within 2 wt. % of the total values obtained from low temperature ashing.

For those elements which occur in coal in only one form (i.e., most of the mineral matter constituents, such as Al_2O_3), a precision of 1% and an accuracy of 5% of the measurement can be obtained. These numbers are just those of a typical quantitative analysis of a homogeneous sample using the microprobe.

The data used in the above measurements requires a sample of coal weighing 200 mg, and the actual data acquisition time is 10 minutes for 121 subsamples on the coal sample. To obtain information on additional elements requires an additional 2 minutes per element. The time required is due to computer analysis of each subsample spectrum and may be reduced by using a faster computer. These 121 subsamples provide enough measurements to determine the correlations between the elements sufficiently well for the MASC analysis.

The MAPS (Microprobe Analysis of Particle Sizes) method for particle size determination has evolved from the MASC analysis. There is a great need for obtaining the pyrite size distribution in order to optimize mechanical cleaning procedures. There is obviously information about the size distribution contained in the data. The MAPS method extracts this information through a fitting procedure to determine an average particle number density (number of particles per unit volume of coal) and a distribution function for the particle sizes. This information on particle sizes is found to be in good agreement with data from washability studies on two coals.

In Section I, the MASC procedure for sulfur forms is described, and the results for 17 calibration coals are discussed. Section II describes the particle size (MAPS) procedure and evaluates the results in terms of washability. Section III is an evaluation of the use of an elemental analyzer for total nitrogen measurements. Section IV details the application of MASC to the major minerals, and in Section V the results of these measurement techniques are applied to seven coals supplied by EPA.

I. SULFUR FORMS

A. INTRODUCTION AND BACKGROUND

The determination of the sulfur forms in coal using the electron microprobe is based on the correlation in the spatial distribution between the various elements in coal. The method was originally described by Solomon and Manzione (Ref. 5). In the simplest case of a coal containing only organic sulfur and pyrite sulfur (FeS_2), with no other sources of iron or sulfur, then the result of a measurement of those two elements over any small region (subsample) in the coal will show a mixture of the organic sulfur and the pyrite. If it is assumed that the organic sulfur is uniformly distributed, and that the pyrite is spatially distributed in small, discrete pieces, then a series of subsamples will each have the same amount of organic sulfur plus a varying amount of pyrite sulfur. The iron measurement will show the same variation in intensity as the pyrite sulfur, and if a plot is made of sulfur vs iron for the various subsamples as in Figure I-1, the data will fall on a straight line whose slope determines the pyrite stoichiometry, and whose intercept on the sulfur axis at zero iron represents the organic sulfur. MASC (Microprobe Analysis of Sulfur in Coal) is an automated technique for performing these analyses, with additional elements added for determining the clay components and for correcting the iron measurement for the presence of iron-bearing clay. In addition, it is possible to distinguish between pyrite and sulfate mineral sulfur, by observing the presence of a high correlation between the sulfur and calcium.

B. EXPERIMENT PROCEDURES

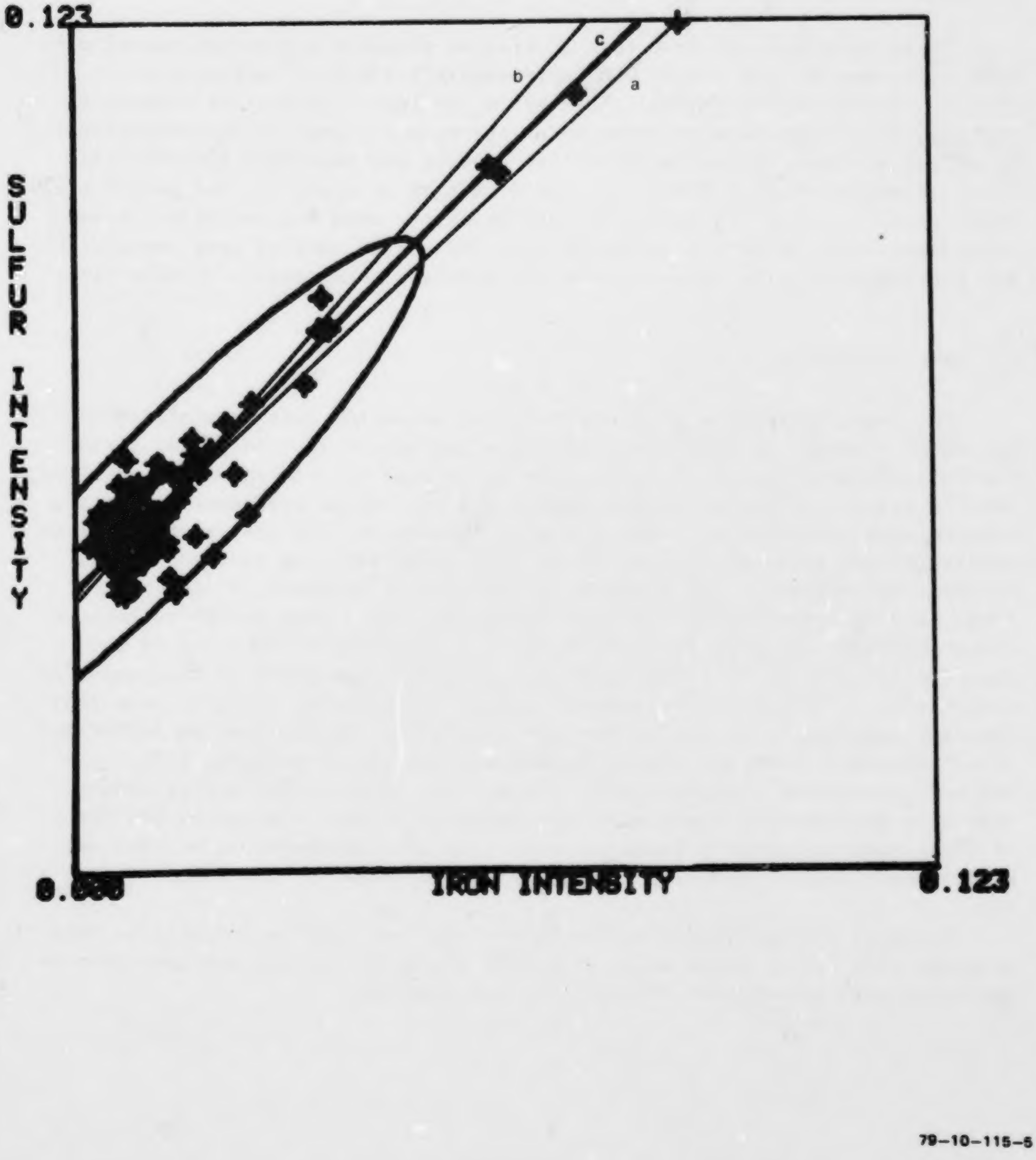
The sulfur in coal analysis is performed on a Cameca scanning electron microprobe with two wavelength-dispersive crystal spectrometers, a Tracor-Northern TN2000 energy-dispersive spectrometer, and a Canberra stage and column automation system, all operating under the control of a PDP 11/04 minicomputer. The MASC computer program acquires the data for several elements at 121 different subsamples on a coal sample and stores the data on a magnetic floppy disc for further analysis.

Sample Preparation

The coal samples are prepared for microprobe analysis by grinding in a tungsten carbide capsule to at least 100 mesh, and then pressing 200 mg

FIG. I-1

EXAMPLE OF MASC PLOT



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pellets in a standard 13 mm diameter pellet press at 20,000 psi. This provides a reasonably smooth surface for the microprobe to analyze. A variety of different grinding sizes were tried during the course of this program, and it was found that the best results were obtained with coal so finely ground that the high density particles (i.e., pyrite and clay) were small enough that the electron beam could penetrate them completely. This eliminates particle size effects from the microprobe analysis of sulfur forms. This requires that the pyrite be ground to a top size of one or two microns. Since this is at the limit of conventional dry grinding techniques, the samples were ground for an hour.

The pressed pellets were then mounted on standard microprobe mounts with silver Micropaint, and coated with approximately 200 Å of carbon in a sputter coating vacuum system. The carbon provides a conductive coating on the samples to eliminate charging under the electron beam in the microprobe. No effort was made to determine if this coating was necessary for coal samples. Previous work at UTRC used a gold coating on coal, but the gold M X-ray lines interfere with the sulfur K lines which are used for analysis. Several experiments were performed to verify that the carbon coating gave reproducible and consistent results compared with the previous measurements at this lab.

C. DATA ACQUISITION

The computer program which controls the automated data acquisition has two major phases: an initialization phase and an acquisition phase. During the initialization phase, X-ray spectra to be used as references are acquired; and the stage coordinates of the samples and the pyrite reference sample are entered into the computer. The reference spectra for the energy spectrometer consist of the relevant portion of the full X-ray spectrum for each of the elements of interest. For example, for the sulfur standard, a spectrum is taken on a polished pyrite flat for 30 seconds, i.e., long enough to acquire a statistically accurate sulfur K X-ray line, and then the portion of the spectrum containing the sulfur peak and about one peak-width of background on either side is stored in the computer memory. Similarly, the iron peak from the same spectrum is stored as the iron reference. In addition to sulfur and iron, reference peaks are stored for Al, Si, and Ca, from Al_2O_3, SiO_2, and $CaWO_4$ standards, respectively. The pyrite, alumina, and silica standards were used because these were considered to be most similar to the forms of these elements usually found in coal. The calcium tungstate was the only readily available Ca standard (it was already mounted in the microprobe).

Although the wavelength spectrometers were not used extensively in this program, they can be tuned up on a desired standard, and standard intensities and background intensities entered into the computer.

Once this initial information is stored in the computer, the analysis is started. For each sample, the computer moves the stage to the sample, asks the operator to check the focus, magnification, beam current, and other parameters of the probe, and then the computer initiates an analysis of the first subsample. This consists of a full energy spectrum, the intensities of both crystal spectrometers, the length of time of acquisition, and the integrated absorbed sample current during that time. Because the subsequent reduction of this energy spectrum takes about five seconds, the acquisition time is set to five seconds. The stage is then moved to a different subsample, and the acquisition cycle is repeated with the spectrum being stored in a different part of the computer memory. While this data is being acquired, the previous data is being reduced by doing a least-squares fit of the reference peaks to the unknown spectrum to determine the ratio of the unknown to the reference peaks including background correction (i.e., the usual k-ratios) using the Tracor-Northern program 'XML'. This process repeats until 121 data subsamples have been analyzed, and then the stage moves to the next sample and repeats the procedure. The fitting procedure will calculate k-ratios for all references which have been entered during the initialization, up to a maximum of 20.

Before every other sample, the same analysis is performed for nine subsamples on the pyrite flat to verify that the microprobe has not drifted in energy calibration, beam current, etc.

Thus, for every sample, there is stored on floppy disc a set of nine or more measurements (2 crystal spectrometer intensities, integrated beam current, measurement time, and k-ratios for Fe, S, Al, Si, and Ca plus any additional elements) at 121 subsamples plus the same data for nine subsamples on pyrite.

The measurement time per subsample is subject to several constraints: we wish to complete the measurement in as short a total time as possible subject to the requirement of adequate statistics for each subsample point. The subsample-to-subsample variation in the iron peak intensity, for example, is typically comparable to the average value of the iron intensity. This requires that the number of counts in the iron peak should be, say 10 or 20, in order to observe the subsample-to-subsample variation with good statistics. For a 1% pyrite sample under the conditions used, this corresponds to a 1/2 to 1 second sampling time. Thus, in practice, the acquisition time is limited by the data reduction as mentioned above. The second important point here is that the average intensities, for the coal sample as a whole, are determined from the full set of 121 data points, which represents 10 minutes of acquisition time, which is more than sufficient.

The beam conditions used are 3×10^{-9} amps beam current at 2000X magnification for the finely ground samples used for the sulfur forms measurements. At these currents, the crystal spectrometer gave essentially zero counts during five seconds, and so were not analyzed. The same sample current was used in the particle size measurements, which employ 1000X for the 100 mesh samples and 2400X for the 40 mesh samples. For some of the particle size data, beam currents of 2 x 10-7 amps were used, and the data from the crystal spectrometers was used instead of the energy data.

). DATA REDUCTION

The basic measurement considered here is the measurement of the sulfur concentration in coal. This is assumed, as first approximation, to be made up of two parts: uniformly distributed organic sulfur, S(O), and spatially distributed mineral sulfur, S(M), which is mainly pyrite and is correlated with iron. We can then write that the total sulfur, S(T), is given by

$$S(T) = S(O) + S(M). \quad \text{(weight \% dry basis)}$$

If we now assume that these two constituents generate X-rays with different efficiencies, so that

$$S(O) = ak_{S(O)}$$

and

$$S(M) = bk_{S(M)}$$

where the k's are the sulfur k-ratios for the two different sulfur forms, we can solve the first equation as follows:

$$1 = a\left[\frac{k_{S(O)}}{S(T)}\right] + b\left[\frac{k_{S(M)}}{S(T)}\right]. \qquad \text{(I-1)}$$

If we now have a procedure for separating the mineral and organic components of k-ratios, we can use this equation with the ASTM values for total sulfur to determine the values for the efficiencies a and b.

There are several possible ways of analyzing the data to determine the relative amounts of the two sulfur k-ratios. In the event that a plot of the sulfur data versus the iron data shows a straight line with no scatter, the intercept of that line is $k_{S(O)}$ and the difference between the average k_s and $k_{S(O)}$ is the mineral $k_{S(M)}$. For some of the very high pyrite coals, this is nearly the case, but for most coals there is considerable scatter on such a plot as seen in Figure I-1.

There are several ways of fitting straight lines to data of this sort. One of the most common is a conventional least squares regression of all but one of the variables as independent variables against the remaining variable as a dependent variable. The drawback to this procedure is that it treats one of the variables, the dependent variable, as special; that is, the procedure assumes that all the variance observed in the measurements is contained in this one variable, and that the remaining variables vary only because they determine different amounts of the dependent variable. At first, we attributed most of the scatter in the data to actual variations in the organic sulfur in the different macerals making up the coal, and thus felt justified in doing the least squares regression. Using the values for the organic and mineral k-ratios obtained in this way in Eq. I-1 gave values for a and b which consistently overestimated the organic sulfur and underestimated the mineral sulfur as determined by the ASTM methods, although they gave fair agreement with the total sulfur measurements.

If it is assumed that the data for iron and sulfur are normally distributed, then a mean and standard deviation can be calculated, and an ellipse can be drawn about the data representing a contour of constant deviation from the mean (see Figure I-1). The least-squares regression of sulfur as a function of iron is the line labeled a in Figure I-1, and it can be seen that this line is the line of least slope that one might draw by eye through the data, and is the line which gives the largest intercept and thus the least mineral component for the k-ratios. Thus, it is not too surprising that this least squares regression overestimated the organic sulfur. The other extreme is the line labeled b, which is the line going through the points of maximum and minimum sulfur, and is the line calculated by assuming that all the scatter is in the iron data. It could be argued that the iron data has all the scatter, since there are random amounts of iron which are associated with clay and not pyrite, but we expect that this effect is included by including the clay through the Al-Fe and Si-Fe correlations. Thus we are led to select a line which is intermediate between a and b. At first glance, the line c through the longest axis of the ellipse would appear to represent the line of highest probability, but unfortunately, this line is not independent of scale changes in the two axes. This can be seen easily by considering data for which the ellipse is very nearly a circle. By changing the scale of the x-axis, one can convert this circle into an ellipse with its long axis parallel to either the Fe-axis or the S-axis. Unless there is a natural set of units for the axes, it is difficult to determine what regression line to choose. In the absence of any such well-defined axis units, we have chosen to calculate the axis of the ellipse for the case where the data have equal variances in all directions; i.e., the data are normalized by the sample standard deviations.

Occasionally, a coal will have a very low iron-sulfur correlation, and this two dimensional analysis is completely inappropriate. The PHS 408 coal supplied by the EPA as part of this program is a case in point and is discussed in detail in section V. This coal has mostly a calcium-sulfur correlation. To deal with these situations, an analysis of the correlations of the other elements is required. A more complex problem is that presented by coals which have significant correlations between more than a single pair of elements. The Scranton and Upper Cliff coals illustrate this. The Scranton coal has comparable correlations of 0.3 for the Fe-S and for the Fe-Al. The Upper Cliff coal has significant correlations for both the Fe-S and the Fe-Si, and in addition has possible nonzero correlations for S-Si and Fe-Al. In order to handle coals of this sort, we have considered the problem of doing the equivalent of the two dimensional regressions in two or more dimensions.

If it is assumed that the various elements are linearly related, that is, that the sulfur k-ratio is a linear function of all the other k-ratios, then any of the regression lines discussed above can be calculated from the sample means, the sample variances, and the correlations between the measurements. This information is easily computed from the data sets for all the elements and is collected in tables in Appendix A. The problem of finding the major axis of an ellipse is easily generalized to the n-dimensional case of finding the axes of an n-dimensional ellipsoid, and turns out to be a straight-forward eigenvalue problem (Ref. 6). The eigenvectors calculated for these correlation matrices are just the vectors parallel to the axes of the ellipsoid through the means of the data, and the eigenvalues associated with each eigenvector represent the relative amount of the total variance which can be explained by assuming that the data fall on the line determined by the eigenvector.

An examination of the eigenvectors can be informative: the components of the eigenvectors the relative amounts of each of the elements required to make up the eigenvectors. Usually, one of the two most likely eigenvectors will have large amounts of iron and sulfur, and small amounts of the other three elements, indicating that iron sulfide is present in the coal. In these cases, the other of the first two eigenvectors will usually have large components of aluminum and silicon, indicating clay. That is, the analysis describes the coal as being pyrite for one vector and clay for the other. This is the case for the PSOC 308 coal, for example. Another common situation is for the first eigenvector to be made up of equal positive amounts of iron, sulfur, silicon, and aluminum, indicating pyrite plus clay; while the other eigenvector has comparable amounts of the elements, but the aluminum and silicon are negative, indicating pyrite minus clay. That is, the analysis describes the sample as having total mineral matter as the most likely vector, with the difference between the two forms of mineral matter being the next most likely. An example of this case is the Montana Lignite coal, labeled LIG in Appendix A.

For the sulfur in coal, we are interested in determining the plane surface which goes through the two largest dimensions of the 5-dimensional ellipsoid. This is equivalent to stating that of the five dimensions measured, three have little or nothing to do with the sulfur, and we find the surface which is orthogonal to these three least probable eigenvectors. This gives three equations among the five variables, which can be solved to give an expression for sulfur as a function of any two of the other four variables. The computer program described in Appendix E is set up to choose the two most significant variables to give the regression equations shown in the tables in Appendix A. Since pyrite is so common in coal, iron is included if it has any significant weight in the first two eigenvectors, even if it is not one of the most significant variables. In the cases where iron is one of the variables, we then assume that the remaining variable determines a correction to the iron for the presence of clay, and an amount of iron due to clay is calculated by extrapolating the clay to zero, holding sulfur fixed at the organic value. The organic sulfur is calculated by extrapolating both the mineral variables to zero. Often the mineral and organic sulfur calculated in this manner will be unreasonable in some respect (i.e., negative values), and this is usually caused by including the clay regression when the correlation with the clay is very small. In these cases, the clay constituent in the regression is set equal to its mean value.

The point to doing the regressions in this manner is that it distinguishes the cases where a simple two dimensional Fe-S analysis is not appropriate. In the cases where a simple two-dimensional analysis is sufficient, this five-dimensional analysis gives the same answers; but when the coal has mostly $CaSO_4$, for example, the Fe-S analysis misses completely, whereas the five-dimensional analysis rejects the Fe completely as in the PHS 408 coal, or modifies it as for the Scranton coal, and the Upper Cliff coal.

E. DISCUSSION OF REPRODUCIBILITY

A series of measurements were performed on one coal, the ISGS coal, to determine the reproducibility of the technique, and the results showed that the sulfur forms are reproducible to about 0.1 percent in sulfur k-ratios, as shown in Table I-1.

TABLE I-1

REPRODUCIBILITY OF SULFUR FORMS FOR ISGS #72 COAL
(average of 10 measurements)

Organic sulfur k-ratio	3.86 ± 0.09
Mineral sulfur k-ratio	0.55 ± 0.11
x in FeS_x (k-ratios)	0.945 ± 0.05

We have not summarized the data on the slope of the sulfur-iron regression in this report because most of the coals considered have either had a slope of nearly 1.0 in the k-ratio plots (or 2.0 in the weight percent basis) indicating near stoichiometry in the pyrite, or else they have had a small enough amount of pyritic sulfur that the regression is not meaningful. However, this slope information can be very useful in considering the behavior of treated coals and chars where the stoichiometry of the pyrite is modified. In addition to the reproducibility of these sulfur forms k-ratios, the correlations for these data sets were reproducible at the ± 0.1 level. Unfortunately, these data were acquired before we had stabilized our procedures, and the data are for 100 mesh coals, which makes the conversion to weight percent unreliable for these data.

F. DISCUSSION OF RESULTS

The calibration constants a and b in Eq. I-1 were determined using a set of seven Pennsylvania State Coal Bank coals and a coal from the US Geologic Survey, ISGS #72, which was used in a round-robin interlaboratory comparison. These eight coals are well characterized as to sulfur forms, and yield values for a and b of 0.63 and 1.12, respectively (Figure I-2). The plot symbols used are summarized in Table I-2.

Using these empirically determined calibration constants, the sulfur forms measurements from MASC are compared with the standard ASTM techniques for total sulfur (Figure I-3), organic sulfur (Figure I-4) and mineral sulfur (Figure I-5) for the above eight coals plus nine additional coals whose sulfur forms had been measured by a commercial laboratory. Except for the two coals plotted as 1 and 3, the agreement between the ASTM method and the MASC method is within about one-half weight percent sulfur. The ASTM methods for sulfur forms (Ref. 1) use a dilute HCl extraction to remove sulfate sulfur, which is then measured by precipitation of the sulfate as $BaSO_4$ using $BaCl_2$. The sulfate-free coal is then treated with dilute HNO_3 to remove the pyrite, which is then determined by measuring the iron, since some of the organic sulfur is removed by the nitric acid wash. Organic sulfur is determined by difference of the pyrite and sulfate from the total sulfur. The total sulfur is determined by one of three methods (Ref. 1). These total sulfur measurements appear to be quite reliable in practice, so that the agreement between the ASTM and the MASC total sulfur is the most meaningful comparison. The accuracy of the ASTM sulfur forms, however, has been the subject of considerable controversy, suggesting that the scatter in Figures I-4 and I-5 could be in either the ASTM or the MASC measurements. The agreement for the total sulfur indicates that the MASC forms is the better one. The agreement for the total sulfur is remarkable since the ASTM method is a direct measurement for total sulfur whereas the MASC method uses the sum of the forms.

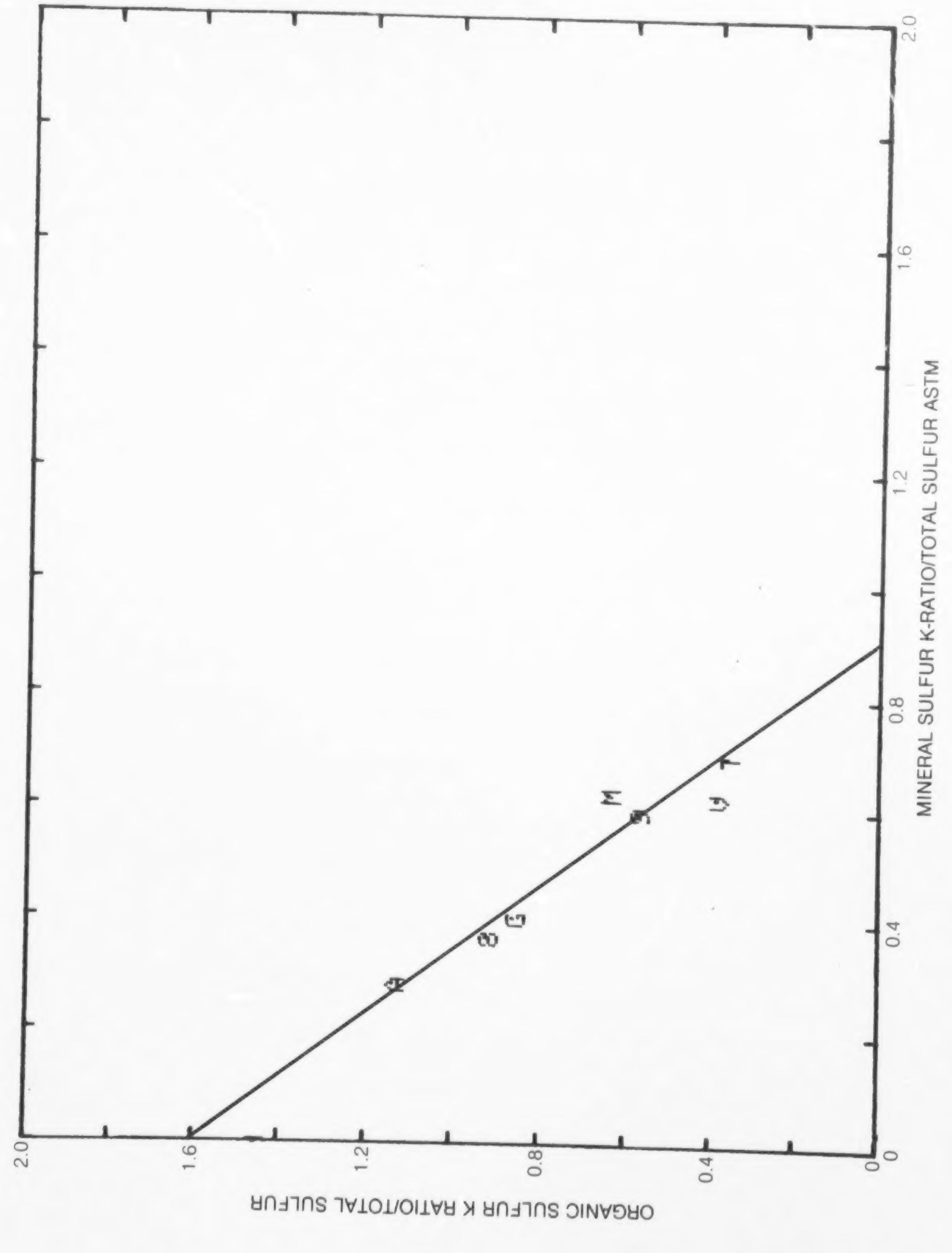
TABLE I-2

PLOT SYMBOLS FOR COAL

Plot Symbol	Coal
A	PSOC 103
8	ISGS #72
G	PSOC 170
J	PSOC 212
M	PSOC 268
T	PSOC 308
V	PSOC 330
4	MONTANA LIGNITE
9	BuMik 40659
E	Scranton, ND
1	Buelah, ND
5	Montana Savage #11
7	Upper Cliff, AL
3	Rosa, AL
F	Black Creek, AL
6	TRW #2 (WV)
2	Utah

FIG. I-2

CORRELATION OF SULFUR FORMS



79-10-115-4

TABLE I-2

PLOT SYMBOLS FOR COAL

Plot Symbol	Coal
A	PSOC 103
8	ISGS #72
G	PSOC 170
J	PSOC 212
M	PSOC 268
T	PSOC 308
V	PSOC 330
4	MONTANA LIGNITE
9	BuMik 40659
E	Scranton, ND
1	Buelah, ND
5	Montana Savage #11
7	Upper Cliff, AL
3	Rosa, AL
F	Black Creek, AL
6	TRW #2 (WV)
2	Utah

CORRELATION OF SULFUR FORMS

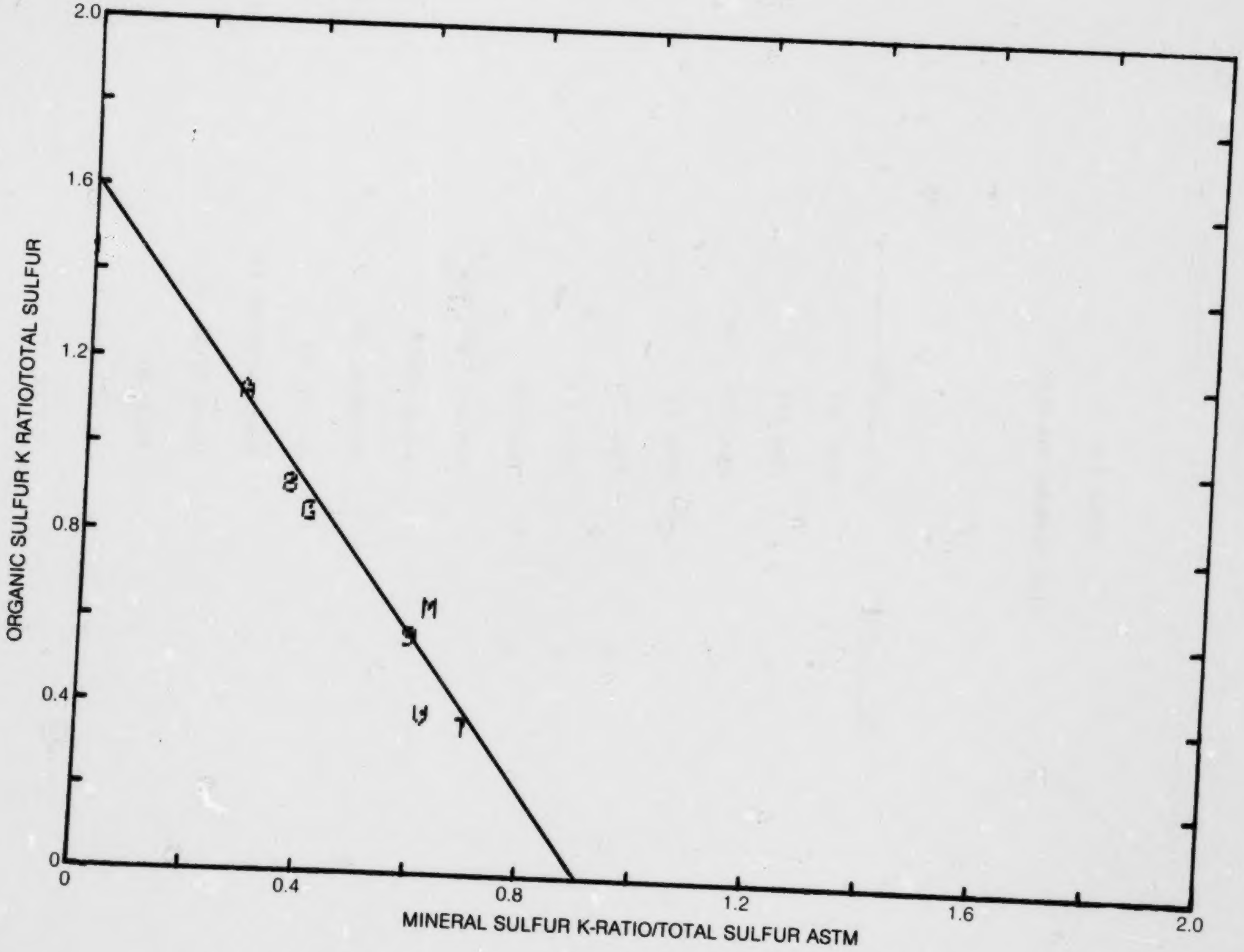
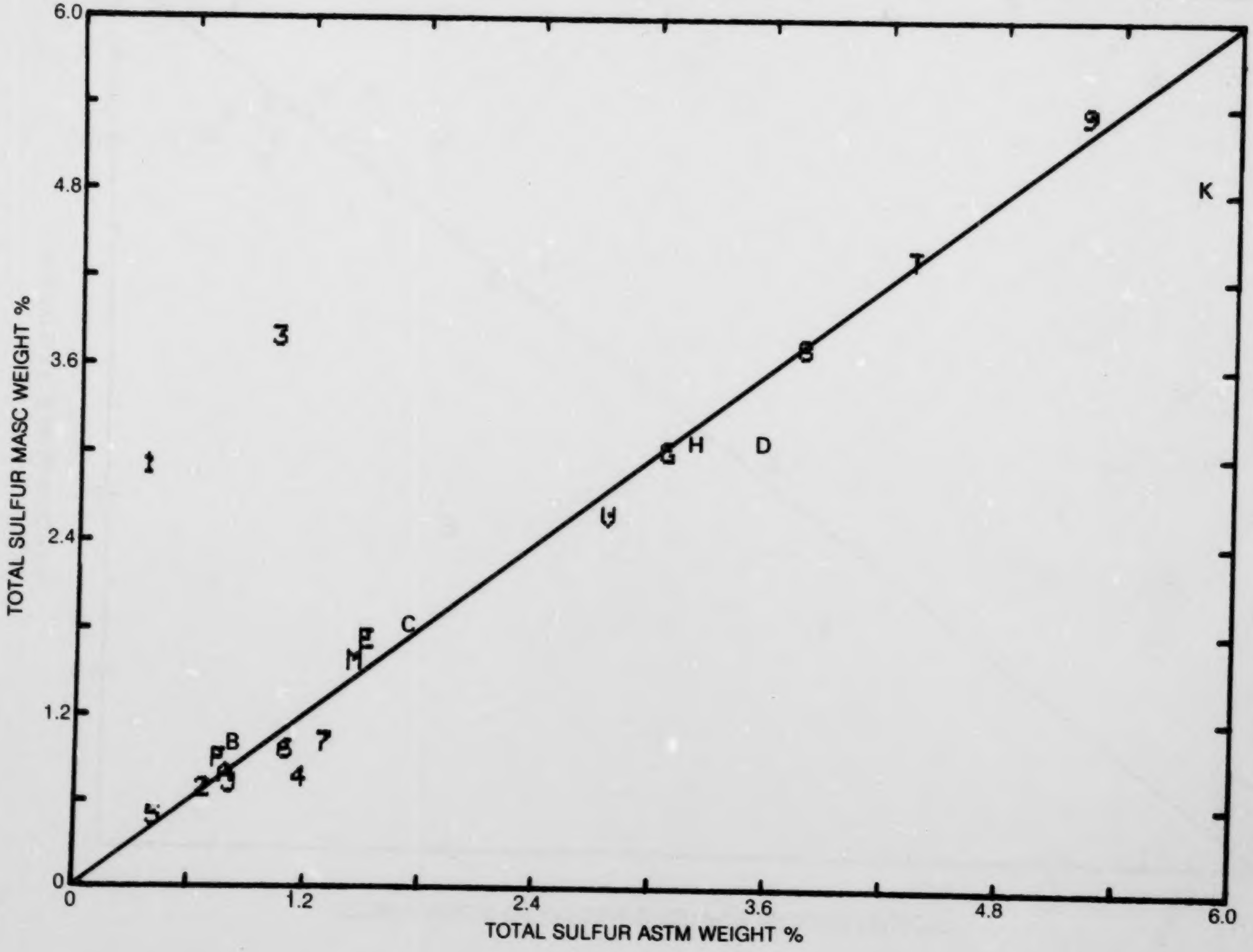


FIG. I-2

79–10–115–4

FIG. I-3

COMPARISON OF MASC FOR TOTAL SULFUR



79-10-115-3

COMPARISON OF ORGANIC SULFUR MEASUREMENTS

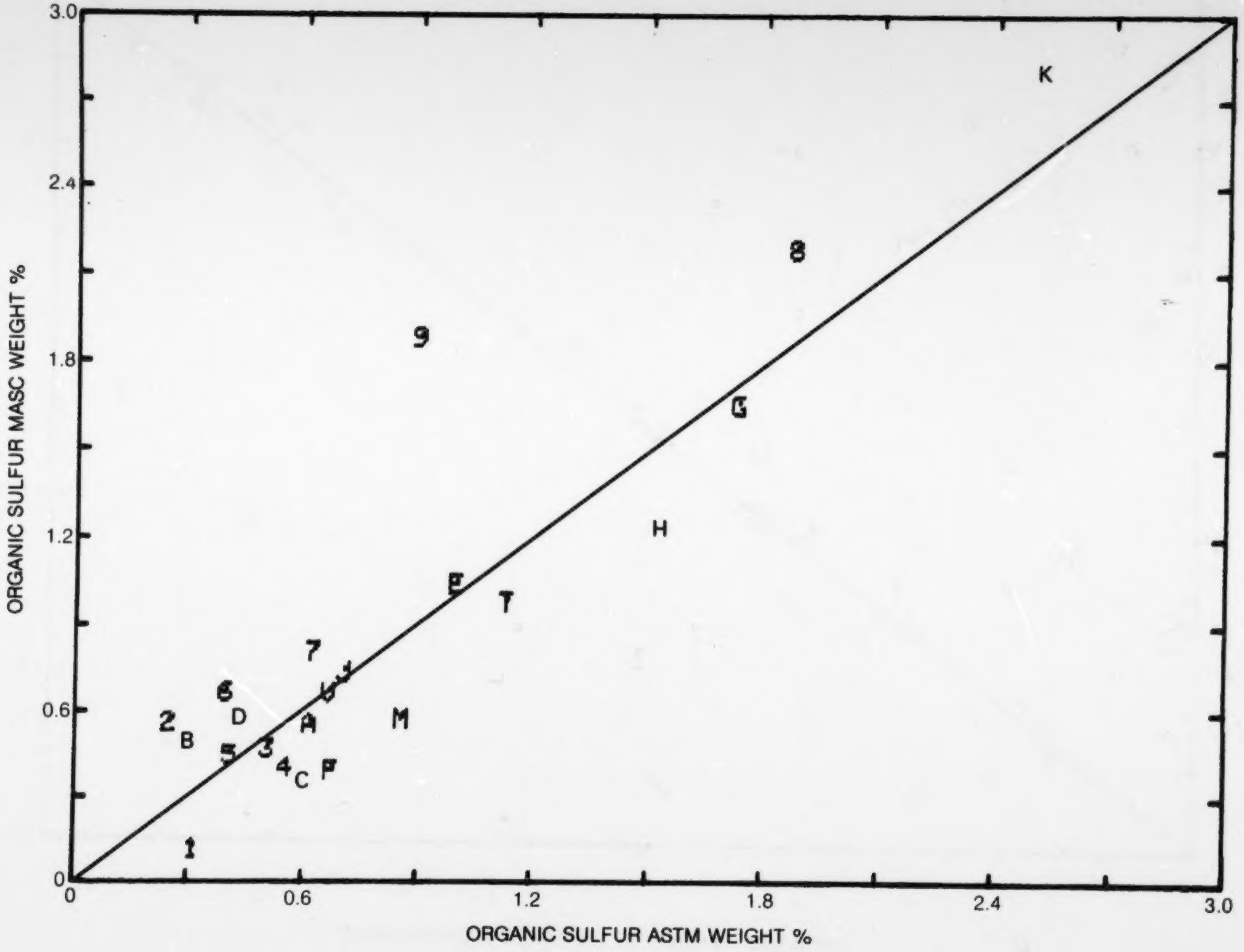
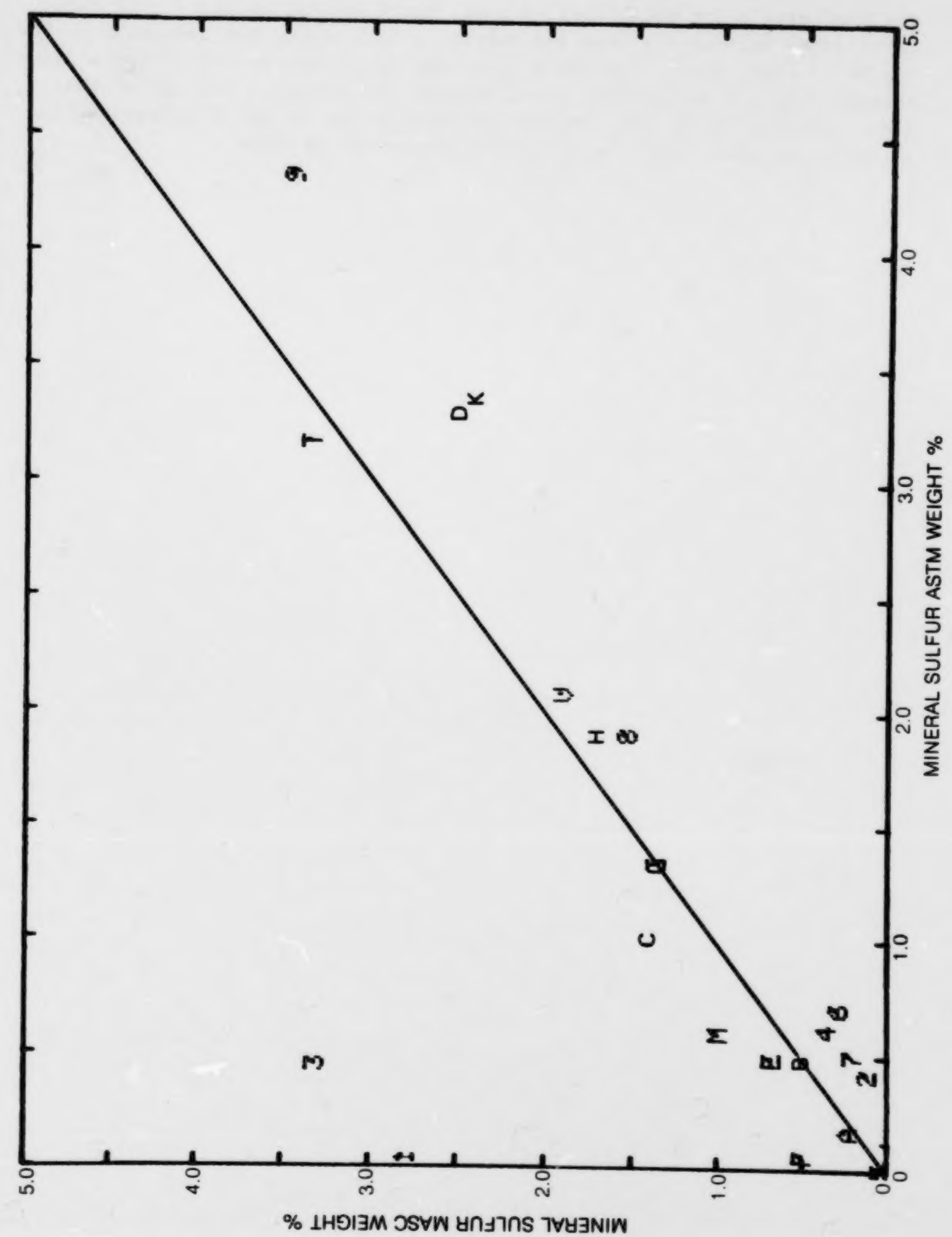


FIG. I-4

79-10-115-2

FIG. I-5

COMPARISON OF MINERAL SULFUR MEASUREMENTS



79-10-115-1

The two coals which do not agree are clearly high in pyrite according to the MASC data. The No. 1 coal, Beulah, North Dakota, showed a very high correlation between the iron and sulfur, with a slope that indicates pyrite. The No. 3 coal, Rosa, also had a very high iron content, but it has a slope between iron and sulfur that would be more indicative of FeS rather than FeS_2. In both cases, the samples are clearly not as low in mineral sulfur as the commercial laboratory measurements would indicate.

II. PYRITE PARTICLE SIZE ANALYSIS

A. INTRODUCTION

The MAPS (Microprobe Analysis of Particle Size) method for particle size determination has evolved from the MASC analysis. There is a great need for obtaining the pyrite size distribution in order to optimize mechanical cleaning procedure and it is toward this use that the current pyrite particle size analysis is targeted. It was also believed that a knowledge of the sulfide particle size distribution would be necessary to correct sulfide concentration from the MASC analysis. However, it has been found both easier and more accurate to grind the coal very finely prior to the MASC analysis, thereby exposing all the pyrite as small particles whose x-ray signal is proportional to volume.

In this section, the basic theory of the MAPS method will be outlined. A series of studies will be presented to show that the method is capable of extracting the desired parameters from the noisy data sets. Limits will be discussed on the amount and type of data needed for the analysis. And finally, the analysis of several coal samples will be presented and the results related to washability data developed for these coals.

B. THEORY

There is pyrite particle size information contained in the MASC analysis data but extracting a size distribution is difficult because of several factors. First, a subsample at one scan position of the scanning electron microprobe can encompass several pyrite particles resulting in an x-ray signal intensity that represents the sum of the signals from the individual particles. The signals received are for elemental iron or sulfur and can have varying amounts of other iron or sulfur containing compounds such as iron oxide or organic sulfur containing compounds mixed into them. Variability in pyrite stoichiometry as well as fluctuations in each of these other possible compounds contribute to the noise in the data. Counting noise is always present in the detection of the x-ray signals. The penetration depth, δ, of the electron beam and the absorption of the emerging x-rays are such that for small particles ($d \lesssim \delta$) the x-ray intensity is proportional to the volume of the particle while for large particles ($d \gg \delta$) the intensity is proportional to the cross-sectional area of the particle. The coal has a rough surface and the pyrite particles are not all on the surface so that ones at greater depths see a weaker electron beam and contribute a small signal.

All of the preceding effects have been considered in the study and procedures have been devised for dealing with them.

Considering a distribution of pyrite particle sizes f(r), it is possible to relate the signal, s, from an individual particle to its radius, r, depth D in the coal matrix, and the efficiency of the detection process, η, by the following approximate relations

$$s \simeq \begin{cases} [\eta\, e^{-D/\Delta}]\, \frac{4}{3}\pi\delta^3\left(\frac{r}{\delta}\right)^3 & r \le \frac{\delta}{2} \\ [\eta\, e^{-D/\Delta}]\, \frac{1}{3}\pi\delta^3\left(3\left(\frac{r}{\delta}\right)-1\right) & \frac{\delta}{2} \le r \le \delta \\ [\eta\, e^{-D/\Delta}]\, \frac{2}{3}\pi\delta^3\left(3\left(\frac{r}{\delta}\right)^2-3\left(\frac{r}{\delta}\right)+1\right) & r \ge \delta \end{cases} \qquad \text{(II-1)}$$

We have assumed that the density of pyrite particles is sufficiently low that the possible shadowing of one particle by another may be ignored. From these relations it is possible to consider a distribution, $\phi(s)$ of signals from individual particles. The efficiency and depth factors in square brackets in Eq. II-1 are taken into account in an overall normalization efficiency as the data in each data set is normalized to pure pyrite signals extrapolated to zero density.

Assuming the distribution $\phi(s)$ to have a mean μ and variance σ^2 the distribution of signals $\psi(S,n)$ expected from a single subsample can be constructed. For a scan which contains pyrite particles randomly drawn from the distribution $\phi(s)$

$$\psi(S,n) \simeq \frac{1}{\sqrt{2\pi n\sigma^2}}\, e^{-\frac{(S-n\mu)^2}{2n\sigma^2}} \qquad \text{(II-2)}$$

for $n \gg 1$

and where

$$S = \sum_{i=1}^{n} s_i \,. \qquad \text{(II-3)}$$

Since the number of particles in the subsample should be distributed according to Poisson statistics, we expect the measured signal distribution to take the form

$$\psi(S) = \sum_{n=o}^{\infty} N\,(n,\bar{n})\ \ \psi(S,n) \tag{II-4}$$

where

$$N\,(n,\bar{n}) = \frac{\bar{n}^{n} e^{-\bar{n}}}{n!}$$

and $\bar{n}$ is the average number of particles per subsample. The MAPS sizing procedure consists of least squares fitting the distribution $\psi(S)$ to the experimental data. The fitting procedure yields three parameters describing the underlying particle size distribution: μ, σ, $\bar{n}$. $\bar{n}$ is related to the mean pyrite particle number density ($= \bar{n}$/subsample volume). To convert the mean normalized signal strength $\mu = \bar{s}$ (mean of the distribution $\phi(s)$) to a mean radius of the particle size distribution, Eq. II-1 is used. The normalization of the data already includes the terms in square brackets in Eq. II-I as well as a factor of the area of the scan subsample.

The MAPS fits are accomplished by taking the MASC data, S_{iron} and S_{sulfur} from a large number of subsamples, N, and forming a distribution by arranging both S_{iron} and S_{sulfur} in from 10 to 30 bins. The least squares fitting procedure would be expected to be more sensitive to μ, σ, $\bar{n}$ for a distribution with a large number of sample bins. However, the number of subsamples in the data set, N, sets a stringent limit on the number of bins that can actually be utilized and conversely the need for sufficient detail in the distribution sets a lower limit on the number of bins that can be used and thereby a limit on the number of subsamples needed for a good particle size determination. Poisson counting statistics for the binning procedure itself implies that to retain 10% accuracy near the peak of the distribution, the bin nearest the peak needs about 100 data points. To spread the distribution over 10 bins then requires N=300 to 400 subsamples for a reasonable MAPS fit. In the coal sample fits presented later, $N \simeq 950$ subsamples are spread over a total of 20 bins including the tails of the distribution.

C. RESULTS WITH SIMULATED DATA

To examine the accuracy with which the parameters u, σ and $\bar{n}$ can be extracted from a data set and to help develop the technique in using the MAPS fitting procedure, a Monte Carlo simulation of the scanning electron microprobe data acquisition procedure was developed. The simulated data is then analyzed by the MAPS fitting procedure. The simulation produces data for an assumed distribution with a selected μ, σ and $\bar{n}$ by generating a random number for the number of particles to appear in a simulated subsample chosen with Poisson statistics with mean $\bar{n}$ and then chooses signal strengths at random from the distribution $\phi(s)$ with the appropriate μ and σ. These individual particle signals are summed as in Eq. II-3. To this $S_{\text{Monte Carlo}}$

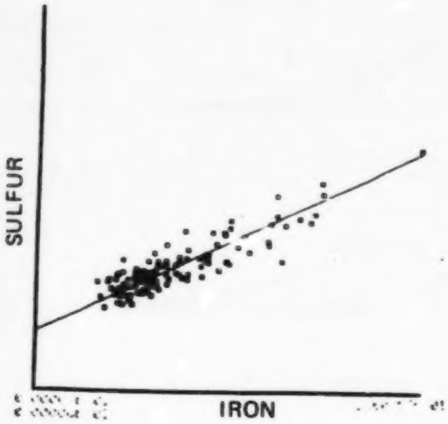
additional signal is added to represent other compounds (e.g., iron oxide or organic sulfur) and additional random noise is added to simulate the variability in these quantities and counting noise in the x-ray detection procedure. This variation could represent an actual concentration variation or it could be due to a variation in the amount of coal actually contained in a given subsample due to surface roughness effects. Also, examination of real data sets shows many with a non-zero minimum for the iron signal which is attributed to the presence of finely dispersed clay particles. Since the clay particle sizes are typically an order of magnitude smaller than the pyrite particles, it appears in the data set as a constant background.

After these additions, the data is normalized by an overall factor. No such points are selected to produce a single data set. An example of such a data set is presented in Figure II-1 along with a real data sample from PSOC 308 coal. This simulated data set was generated by using parameters from a MAPS analysis of the coal data set and shows that the Monte Carlo simulation of the MASC data aquisition program can produce realistic data.

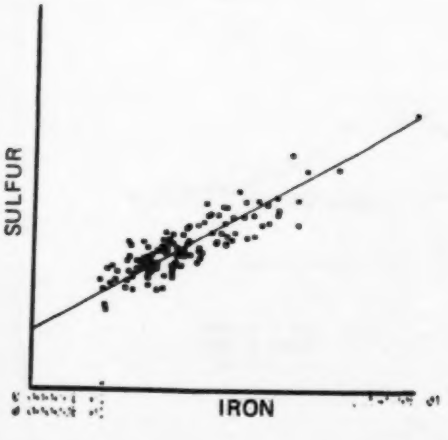
Many data sets were produced by the simulation by varying the basic parameters or by generating a series of different data sets (different random numbers) all with the same parameters. Each data simulation was fitted with the least squares MAPS procedure and the best fit parameters were compared to the input parameters in the simulation. Three examples are shown in Figures II-2(a), (b) and (c). In each figure, the upper histogram represents the simulated data distribution function $\psi(S_{\text{Monte Carlo}})$ for iron while the lower histogram is for sulfur. The dashed lines through the histogram distributions are the best fit of $\psi(S)$ and can be seen to be quite good. These data sets were generated with a least $N=1000$ subsamples each and are therefore fitted with more bins than are used when fewer data points are available. Table II-1 lists the input and best fit parameters for each of these data sets. The agreement is excellent and shows that the system works even for many unusual distributions. The one shown in Figure II-3 was generated with only one particle ($\bar{n}=1$) of a fixed size ($\sigma \ll \mu$) per subsample. The occaional subsamples with $n=2,3,\ldots.$ produce individual peaks in the data signal distribution $\psi(S_{\text{DATA}})$. By varying the form of the underlying distribution function $\phi(s)$, different distributions of radii may be tried such as normal or lognormal. However, as long as the distribution is described by a mean, μ, and variance, σ^2, and as long as $\bar{n} \gg 1$, $\psi(s)$ as given by II-2 applies and the MAPS procedure works reasonably well. In actual practice, the requirement for $\bar{n} \gg 1$ seems to be satisfied for $\bar{n}$ of 2 or 3. There is also an upper limit on $n \lesssim 15$. If $\bar{n}$ grows beyond this, there is too little difference between $\psi(S)$ and a gaussian distribution (Poisson distribution $N(n, \bar{n})$ goes over to a gaussian distribution in the limit of large $\bar{n}$) and the fitting procedure is unable to pick out a good best fit. This means that the scan subsample size should be chosen in such a way as to fall within

FIG. II-1

NUMERICALLY GENERATED DISTRIBUTION COMPARED TO COAL DATA



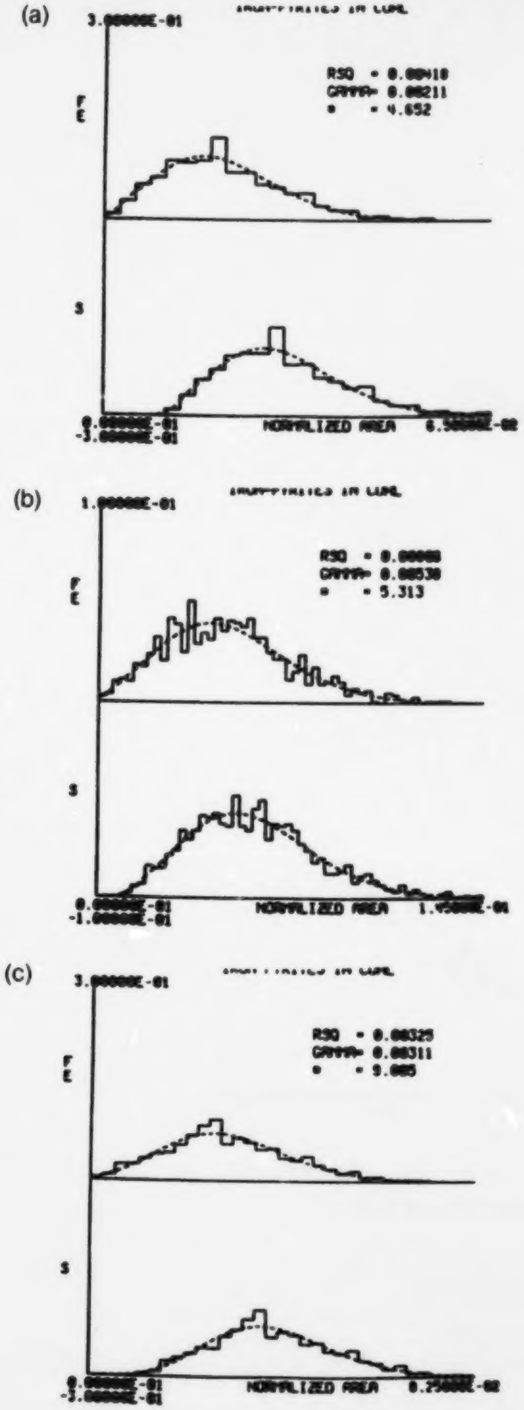
a) PSOC 308 COAL



b) SYNTHESIZED DATA SET WITH ± 25%
VARIATION IN S(O)

FIG. II-2

EXAMPLES OF MONTE CARLO DISTRIBUTIONS FITTED BY PARTICLE SIZE PROGRAM



GENERATED WITH
$\bar{a}$ = 0.004
σ = 0.002
$\bar{n}$ = 5

$\bar{a}$ = 0.010
σ = 0.004
$\bar{n}$ = 5

$\bar{a}$ = 0.003
σ = 0.003
$\bar{n}$ = 10

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TABLE II-1

EXAMPLES OF MAPS FITS TO MONTE CARLO DATA FROM FIGURE II-2

Data	μ Input	μ Best Fit	σ Input	σ Best Fit	$\bar{n}$ Input	$\bar{n}$ Best Fit
Figure II-2						
(a)	.0040	.0042	.0020	.0021	5	4.7
(b)	.0100	.0091	.0040	.0040	5	5.3
(c)	.0030	.0033	.0030	.0030	10	9.0

μ, σ are in arbitrary units

FIG. II-3

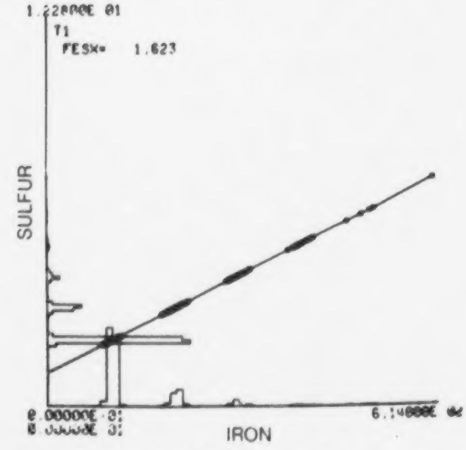
EXAMPLE OF MONTE CARLO DISTRIBUTION FIT BY PARTICLE SIZE PROGRAM

GENERATED WITH

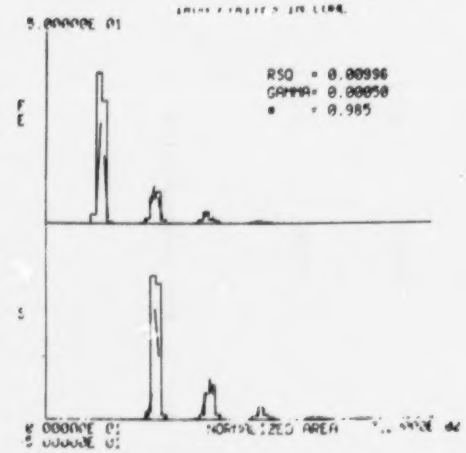
$\overline{a} = 0.010$

$\sigma = 0.005$

$\overline{\pi} = 1$



a) SULFUR VS. IRON PLOT



b) IRON AND SULFUR DISTRIBUTION FITTED

79–10–115–7

the limits $5 \lesssim \bar{n}$ 15. In practice, other considerations tend to push the scan magnification ($\underset{\sim}{\propto}$ 1/subsample size) to high values. Measurements are therefore made at the lower limits for $\bar{n}$ and for the validity of the approximation of $\Sigma\, \phi_i(s)$ by $\psi(s)$.

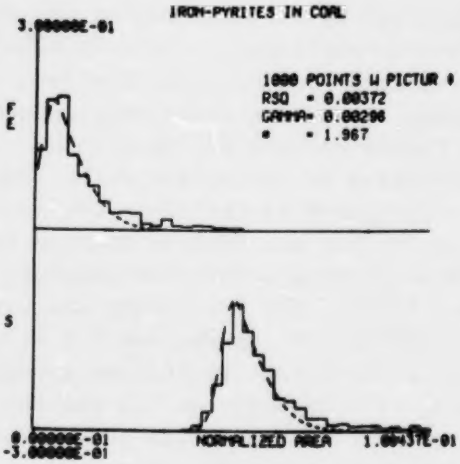
D. RESULTS FOR COALS

As a test of pyrite particle sizing procedure, an extensive data set run on the microprobe on ISGS #72 coal was used. Figure II-4 shows the results of two fits of ISGS coal by the MAPS sizing procedure. This data set contains approximately 1000 subsample data points to reduce the statistical sampling error. In the fitting procedure, the iron data (upper histogram) and sulfur data (lower histogram), which are taken independently, are treated so that the iron data may be fitted and the fit related by the best fit slope and intercept from the MASC procedure to the sulfur data. Similarly the sulfur data may be fitted alone and related by the slope and intercept to the iron data. The data for iron and sulfur may both be used in the fit, thereby doubling the effective number of data points contributing to the data distribution for $\Psi(S)$. In Figure II-4(a) the iron alone was used for the dashed fitted curve yielding μ = .00372, σ = .00296, and $\bar{n}$ = 2.0. If the sulfur data alone is used (Figure II-4(b)) the results are almost identical: μ = .00385, σ = .00306, $\bar{n}$ = 2.3. The iron fit in (a) and the sulfur only fit in (b), each show slightly better fits near the peak of their respective distributions. For this data set, the scan subsample size is 100μ by 100μ for a magnification 1000X. The penetration depth in the pyrite at the accelerating voltage used is δ = 1.8 μ. Using Table II-2 prepared using Eq's II-1 for this voltage, we find $\bar{r}$ = 2.7μ for this ISGS coal data.

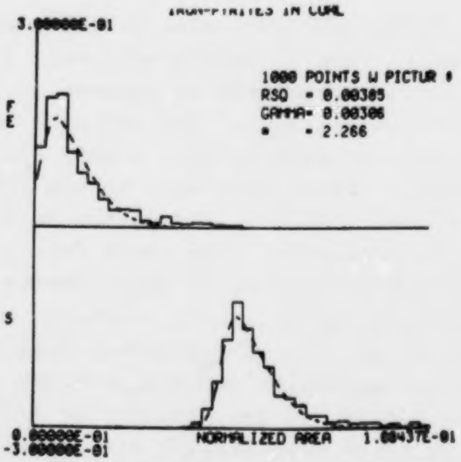
A series of 55 photomicrographs were made at the same time the data was being taken on this ISGS cool. The 55 data points were identified in the full 1000 point data set and are shown enclosed by squares in the standard sulfur versus iron plot shown in Figure II-5(a). The pictures represent a good sampling of the full data set; so much so that a MAPS fit of the 55 point data set yields best fit parameters almost identical to the results shown in Figure II-4. With so little data, both the iron and sulfur data were fit together to improve the statistics. The histograms from these data together with the best fit are shown in Figure II-5(b). Samples of these photographs are included as Figure II-6. These are taken using Fe x-rays, each dot on the photograph representing an emitted Fe x-ray. The three pictures at the bottom of Figure II-6 include very large areas with high Fe concentration which we call pyrite rocks. These rocks appear far out in the high pyrite tail of most data sets and are separated in the particle size fitting procedure as these rocks form a separate size distribution. The upper six photographs are representative of the data included in the fit. They show a finely divided Fe background and a number of pyrite particles of varying sizes (similar photographs taken with S

FIG. II-4

ISGS COAL FITTED BY PARTICLE SIZE PROGRAM



a) ONLY IRON DISTRIBUTION FIT



b) ONLY SULFUR DISTRIBUTION FIT

79-10-115-8

TABLE II-2

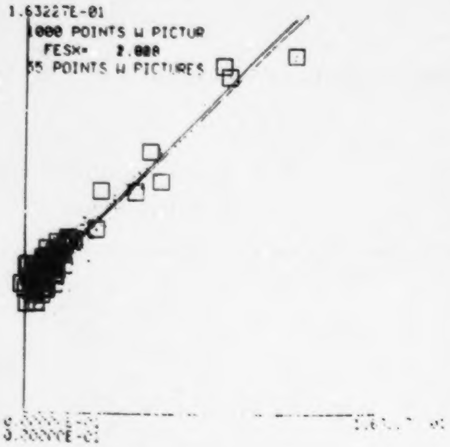
AVERAGE PARTICLE RADIUS VERSUS AVERAGE PARTICLE SIGNAL

For Penetration Depth $\delta = 1.8$

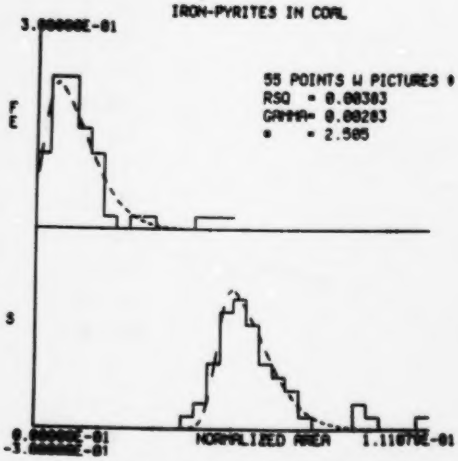
$\bar{n}$ (Microns)	$\bar{S} = \mu \times$ subsample area $= \mu \times (10^5/\text{Magnification})^2$
.2	.03
.4	.27
.6	.91
.8	2.2
1.0	4.1
1.2	6.1
1.4	8.1
1.6	10.2
1.8	12.2
2.0	16.7
2.2	22.2
2.4	28.5
2.6	35.7
2.8	43.9
3.0	52.9
3.2	62.9
3.4	73.7
3.6	85.5
3.8	98.0
4.0	112.0
5.0	193.0
6.0	297.0

FIG. II-5

ISGS COAL ANALYSIS WITH PHOTOMICROGRAPHS



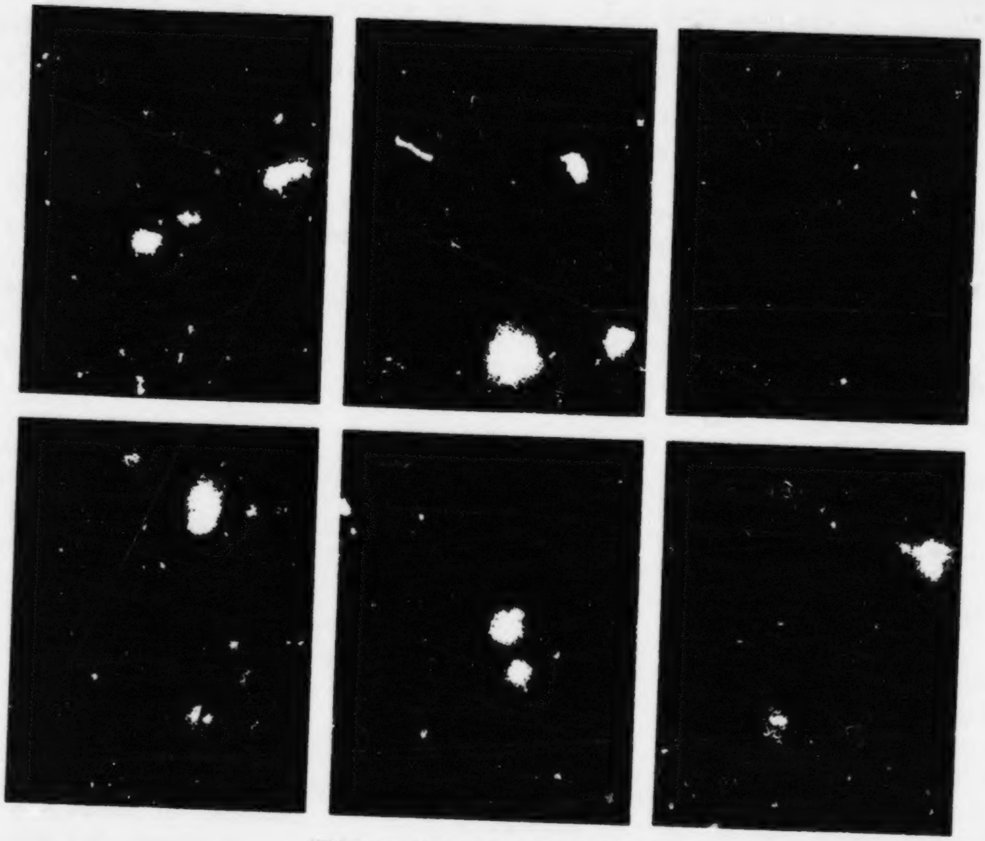
a) SULFUR VS. IRON PLOT WITH
POINTS WHERE PICTURES WERE
TAKEN INDICATED



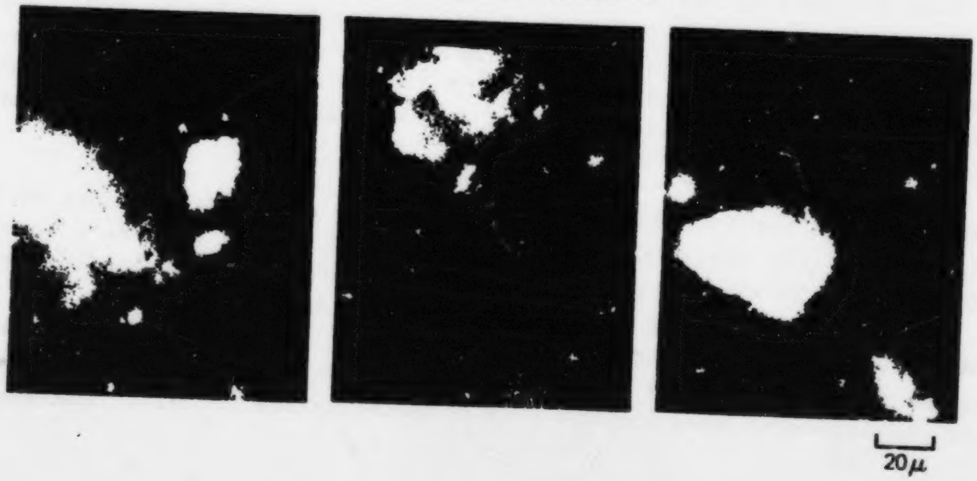
b) PARTICLE SIZE FIT OF POINTS
IN PICTURES

FIG. II-6

FITTED PYRITE DISTRIBUTION FROM ISGS COAL



"ROCKS" DISCARDED BEFORE FIT



79-06-136-1

x-rays confirm that for this coal these are indeed pyrite particles). The background Fe may come from highly dispersed fine pyrite particles or other Fe compounds and is sometimes subtracted from the data. The sum of the areas of all the remaining particles in one frame represent the data used in the computer particle size fitting procedure. From the MAPS fit of the data sets as shown in Figures II-4 and 5, we found average particle radii of 2.7μ or 5.4μ diameters. This represents a very good fit of the full distribution in both Fe and S and is also in excellent agreement with the photographic sample. As a comparison, in Figure II-6, the bottom middle picture of the six contains two nearby pyrite particles with diameters of 5μ and 8μ.

Two other samples of coal analyzed by the MAPS procedure are PSOC 308 and PSOC 330 coals. The sulfur versus iron plots for the N=950 subsample data sets are shown in Figures II-7(a) and (c). The ellipses shown in the figures represent the 2.0 standard deviation ellipses for a bivariate normal distribution with means determined by the data and a correlation coefficient of 0.76 for the 308 and .98 for the 330 coal. The lines represents the semi-major axes of the ellipses.

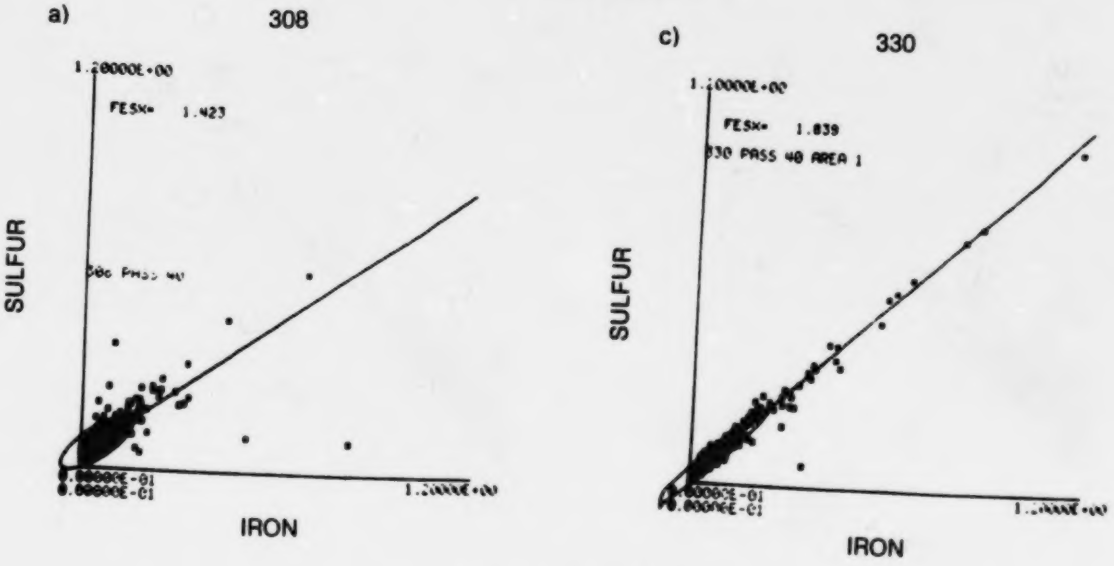
The data points near or outside of the ellipses in Figure II-7 represent subsamples containing pyrite "rocks" as shown at the bottom of Figure II-6. The rocks are not well represented by the distribution functions $\psi(S)$ and form a small but very long tail for the data distributions. Figures II-7(b) and (d) show the data subsamples in the sulfur versus iron plot that are eliminated by the 2.0 standard deviation pyrite rock cut. For the 308 data set they represent 48 out of 968 subsamples or just 5%. However these large rocks contain 23% of the iron signal and when the volume effect is taken into account-possibly 50% of the total pyrite volume in the coal. Similarly, for the 330 coal, they represent 6% of the data points, and 30% of the iron signal. These large rocks seem to represent a very uniform distribution up toward the limit imposed by the subsample size - a diameter of about 40μ - rather than the tail of say a log-normal distribution. Further, for washability criteria, the large rocks represent an easily removed background. Therefore to simplify the particle size fitting procedure by limiting the number of bins that must be processed in the analysis, a cut is made in the data throwing away all data samples outside this 2.0σ ellipse. The data thus discarded are shown in Figure II-7(b) and (d).

The raw data for PSOC 330 coal also contained a considerable gap on the low side of the iron distribution, presumably from lightly dispersed iron in clay particles. This gap represented 11% of the mean value of the iron signal $\bar{S}_{iron}$. This iron background has been substracted from each iron value and the resulting data is shown in Figures II-8(c) and (d). This results in moving the iron histogram in Figure II-8(d) over to the $S_{iron} = 0$ axis and no bins on the left have been lost in this renormalization process. The abrupt

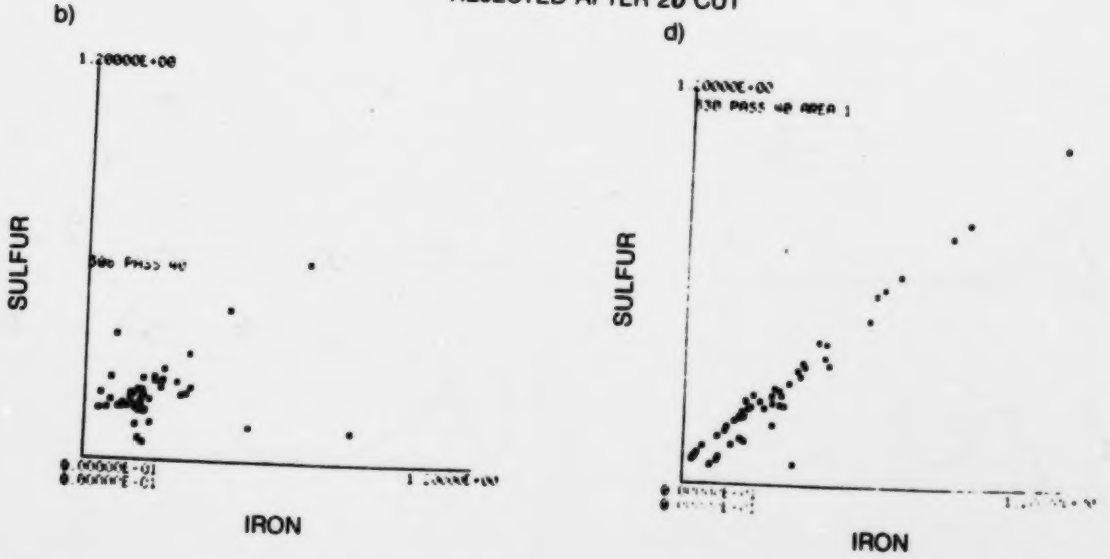
FIG. II-7

PSOC 308 AND 330 PYRITE PARTICLE SIZE ANALYSIS

ALL DATA



REJECTED AFTER 2σ CUT

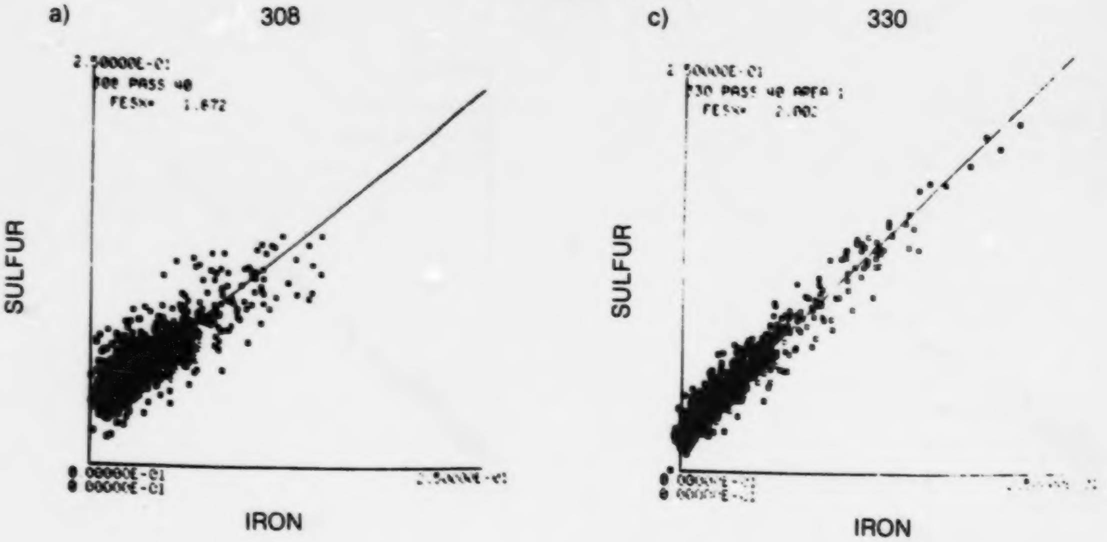


79-11-5-3

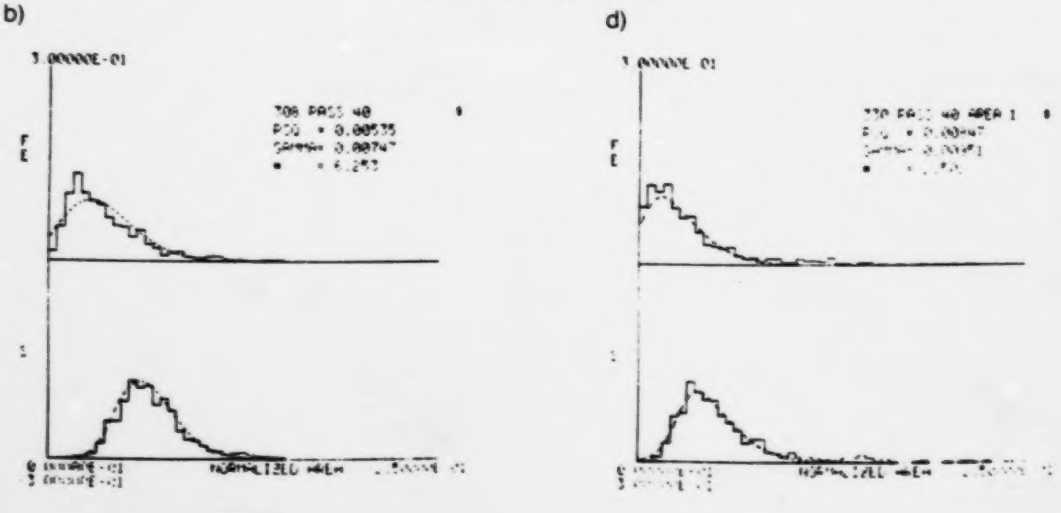
FIG. II-8

PSOC 308 AND 330 COALS FITTED FOR PYRITE PARTICLE SIZE

DATA USED FOR FIT



PARTICLE SIZE FIT



79-11-5-4

cutoff of this and many other coal distributions on the low iron side represent good evidence for the dispersed iron. The apparent presence of iron in clay for PSOC 330 and none in PSOC 308 is also borne out by the multivariate analyses including elements abundant in clay particles such as Si and Al and is discussed further in other sections. No abrupt gap is observed in the PSOC 308 coal (Figures II-8a, b).

The data after the dispersed iron subtraction and the pyrite rock cutoff was binned in 30 bins along the iron signal axis and the resulting distribution fitted by the MAPS procedure. The MAPS fit for the PSOC 308 coal yields σ = 0.0054, μ = .0075, $\bar{n}$ = 6.3 (Figures II-8b). The fit for the 330 coal resulted in σ = .0086, μ = .0108, and $\bar{n}$ = 2.2. These data were taken with a magnification of 2400X or a subsample size of 42μ x 42μ. This yields an average radius of 1.5μ for the 308 and 1.9 for the 330.

E. COMPARISON WITH WASHABILITY DATA

There are clearly differences in the particle size distribution between PSOC 308 and PSOC 330. The differences in the distribution of rocks is evident in Figure II-7. PSOC 330 has a much higher number of large pyrite rocks. PSOC 308 has fewer high sulfur-high iron particles and some of those appear not to be pyrite as evidenced by their non-pyrite sulfur-iron stoichiometry. The distribution of small pyrite particles is also different as evidenced in Figure II-8. PSOC 330 has a wider distribution of sulfur and iron intensities which is indicative of a higher concentration of larger particles. This indication is confirmed with the particle size analysis which shows the average particle radius for PSOC 330 to be 1.3 times that for PSOC 308. This gives an average pyrite particle weight for PSOC 330 which is more than twice that for PSOC 308.

A washability study was performed on these two coals to determine whether the predicted differences in particle size distribution was apparent in their ease of cleaning. Samples of the 40 mesh coal were ground to pass 100, 200 and 325 mesh and subjected to centrifuging in 1.4 and 1.6 specific gravity fluid. The results are shown in Figures II-9 and 10. Figure II-9 for PSOC 330 shows substantial scatter in the data but indicates excellent cleaning characteristics for particle sizes of 100 mesh and below. In view of the high concentration of very large pyrite particles in this coal, the scatter in the data seems to be a sampling problem. Figure II-10 for PSOC 308 shows a different cleaning behavior. There is a much more gradual fall off of pyrite concentration with decreased particle size and incomplete cleaning even at 325 mesh. These data are consistent with the particle size distribution results and suggest the desirability of further work on these techniques to allow quantitative prediction of the washability potential of a coal.

WASHABILITY STUDY ON PSOC 330

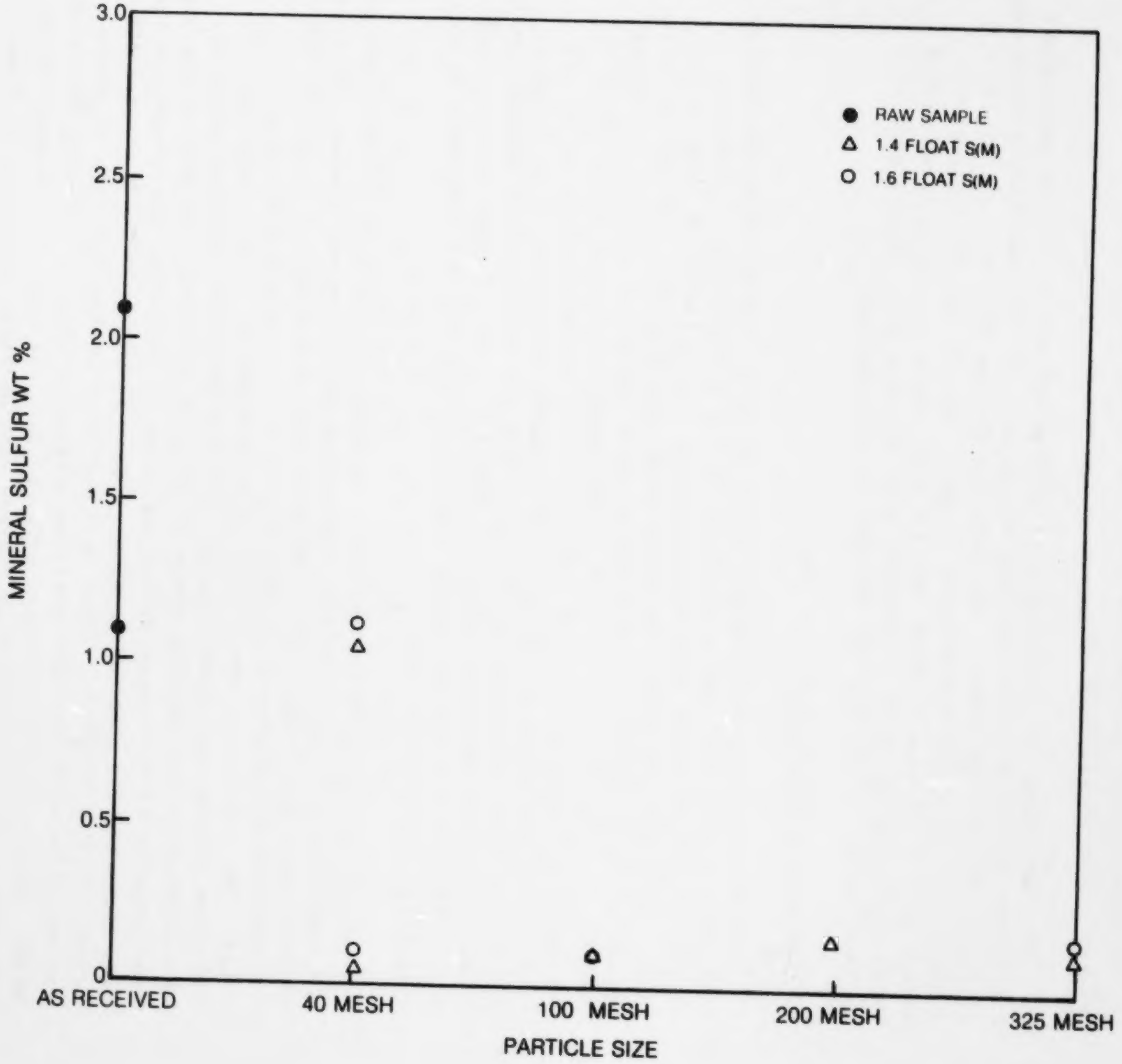
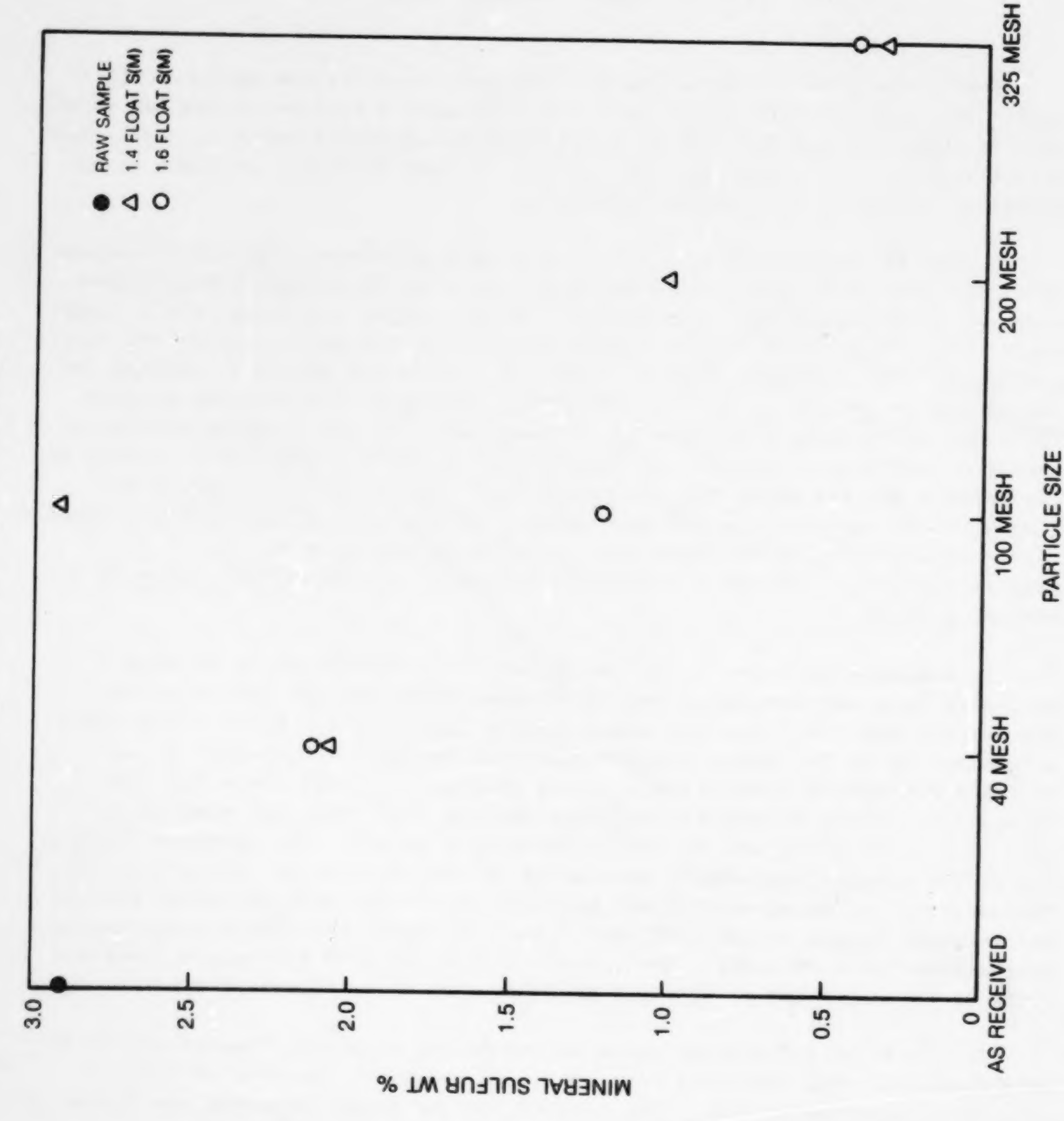


FIG. II-9

79-11-5-1

FIG. II-10

WASHABILITY STUDY ON PSOC 308



79–11–5–2

III. TASK IV - TOTAL NITROGEN CONCENTRATION

There is a need for improving the nitrogen concentration measurements in coal. The standard ASTM method (Ref. 1) which uses a Kjeldahl digestion is of questionable accuracy for tightly bound nitrogen compounds found in coal. The method is also time consuming. The purpose of TASK IV was to evaluate an alternative procedure for nitrogen analysis.

Elemental analyses of nitrogen in coal were performed with a Perkin-Elmer Model 240 element analyzer. The Model 240 performs an automated Pregl-Dumas analysis on approximately 2 mg samples. These samples are taken from a larger sample which has been finely ground to insure that the small samples are representative. The automated analysis takes 15 minutes per sample to perform and yields the ash weight as well as the carbon, hydrogen, and nitrogen weights. The Model 240 is connected to a PDP 11 computer as is the weighing balance so that the recording of results and data reduction are all automatic. Access to the balance and the Model 240 is through a dry box so that the samples are always maintained within a dry environment. Table III-1 illustrates the typical reproducibility of measurements. Reproducibility from one run to the next is typically ± 3% for nitrogen and hydrogen ± 1% for carbon, and ± 5% for ash and missing.

To evaluate the accuracy of the PE 240, coal samples whose nitrogen concentrations had been determined by standard ASTM methods were measured. The results for nine coals are summarized in Table III-2. Seven of the coals were supplied by The Energy and Environmental Research Corporation as part of EPA's Fundamental Combustion Research program, one coal comes from the Pennsylvania State University coal bank and one (ISGS #72) was supplied as part of a round robin test by the US Geological survey. The agreement between the PE 240 results and results determined by ASTM methods is typically ± 10%. The question is, which results are more accurate? The most carefully handled and measured sample is the ISGS coal. But even here, the ASTM nitrogen value ranges from 1.01% to 1.39%. The reproducibility of ASTM nitrogen determinations on two other coals, Rosa and PSOC 170 also shows substantial variation.

To obtain an independent check on the PE 240 accuracy, 3 model compounds were measured. The compounds were chosen to represent the kind of nitrogen structures expected in coal. The results for the three compounds are listed in Table III-3. The variation between the PE 240 value and the theoretical value is within ± 1%.

In summary, it appears that the PE 240 gives accurate and reproducible results for the kind of nitrogen compounds found in coal and probably for coals themselves. The accuracy of the Kjeldahl digestion is in question and needs further study.

TABLE III-2

NITROGEN MEASUREMENTS

	ROSA ALABAMA	BLACK CREEK ALABAMA	UPPER CLIFF ALABAMA	TRW #2	UTAH	ACRIDINE
	1.51	1.87	1.57	1.42	1.49	7.77
	1.55	1.91	1.54	1.33	1.54	7.82
	1.58	1.88	1.58	1.39	1.51	7.82
	1.52				1.62	
AVG.	1.54	1.89	1.56	1.38	1.54	7.80
ULTIMATE	1.74 EER #1	1.79 EER	1.46 EER	1.35 EER	1.41 EER #1	7.82 THEO
	1.53 EER #2				1.42 EER #2	

	PSOC 170	BEULAH N. DAKOTA	SAVAGE MONTANA	OCTAHYDRO-ACRIDINE	ISGS	CARBAZOLE
	1.36	1.00	1.04	7.48	1.25	8.20
	1.41	.97	.97	7.27	1.25	8.35
	1.42	.87	.96		1.25	8.20
	1.40	.89	.99			
	1.41	.86	.95			
	1.48	.85	.96			
	1.31	.90				
	1.43					
	1.43					
AVG.	1.41	.91	.98	7.38	1.25	8.25
ULTIMATE	.13 PSU #1	1.10 EER	1.13 EER	7.49 THEO	1.24 ILL.GS	8.38 THEO
	1.30 PSU #2				1.01 DOE-PETC	
	1.44 HAZEN				1.39 BROKEN HILL AUSTRALIA	

TABLE III-3 ELEMENTAL ANALYSIS OF MODEL COMPOUNDS

		SAMPLE AND ASH WT		WEIGHT %				
	SAMPLE	WEIGHT	ASH WT	NITROGEN	CARBON	HYDROGEN	ASH	MISSING
ACRIDINE	202: ACR-S	1.971	0.004	7.77	86.59	4.92	0.20	0.51
	204: ACR-S	1.952	-0.007	7.82	87.04	4.89	-0.36	0.61
	208: ACR-S	2.003	0.005	7.82	87.23	4.92	0.25	-0.22
	AV 3: DRY AVER	1.975	0.001	7.80	86.95	4.91	0.03	0.30
	THEORETICAL VALUES			7.82	87.15	5.03		
CARBAZOLE	201: CAR-S	2.223	0.005	8.20	85.75	5.26	0.22	0.57
	203: CAR-S	1.951	-0.003	8.35	86.58	5.37	-0.15	-0.15
	207: CAR-S	2.157	0.005	8.20	86.04	5.20	0.23	0.33
	AV 3: DRY AVER	2.110	0.002	8.25	86.12	5.28	0.10	0.25
	THEORETICAL VALUES			8.38	86.23	5.39		
OCTA HYDRO ACRIDINE	131: OHA-S	2.019	-0.005	7.48	84.13	9.55	-0.25	-0.91
	133: OHA-S	2.571	-0.007	7.27	82.06	9.29	-0.27	1.66
	135: OHA-S	2.856	-0.004	7.40	83.68	9.31	-0.14	-0.25
	137: OHA-S	2.185	-0.007	7.32	82.51	9.32	-0.32	1.17
	139: OHA-S	2.277	0.002	7.35	83.41	9.38	0.09	-0.23
	141: OHA-S	2.824	-0.003	7.42	83.77	9.54	-0.11	-0.63
	AV 6: DRY AVER	2.455	-0.004	7.37	83.26	9.40	-0.17	0.14
	THEORETICAL VALUES			7.49	83.42			

IV. MAJOR INORGANICS

The MASC data which was acquired to determine the sulfur forms can also be used to estimate the total amount of inorganics in coal. In order to do this, it is necessary to assume that the inorganic clays are in the form of oxides or carbonates. In particular, it is assumed that the aluminum is present as Al_2O_3, the silicon as SiO_2, the calcium as calcite ($CaCO_3$) and the non-pyrite iron as Fe_2O_3. The reference standards for aluminum and silicon were chosen to be Al_2O_3 and SiO_2 so that no corrections for absorption would be necessary to calculate a weight percent of each of these constituents. Thus we predict that the total mineral matter on a dry basis will be given by

$$MM(dry) = (k_{al} + k_{Si} + 0.285 * k_{Ca} + 0.7 * k_{Fe}) * 1.38 + Pyrite$$

where the 0.285 factor for the Ca is the calculated ZAF correction from MAGIC (Ref. 7) for $CaCO_3$ relative to a standard of $CaWO_4$, and the 0.7 is the factor for Fe_2O_3 relative to a pyrite standard, and the 1.38 is the roughness factor found to be appropriate for the sulfur data. A plot of mineral matter found using this relation is shown in Fig. VI-1 for comparison with mineral matter determined by Low Temperature Ashing or by calculating from the ash analysis. As can be seen from the figure, the agreement is within 2 percent for most coals, indicating that the assumptions used in generating the above relation are reasonable.

It may be possible to estimate the types of clay in the coal from the data since the major clays have definite ratios of alumina to silica which is apparent in the MASC data. A plot of the aluminum versus silicon k-ratios for a sample which was 'salted' with kaolin is shown in Fig. V-2. Similar plots for coal salted with montmorillonite and illite are shown in Figs. IV-3,4. From the slope of the regression between the aluminum and the silicon, we should be able to distinguish between kaolin and the other two clays. The agreement, however, between estimates of kaolin and the other clays using this procedure, and measurements of these constituents using IR spectrometry in this lab is very poor. This MASC procedure for estimating clay components needs more analytical work to determine if there is a regression which does give reasonable results for clays.

FIG. IV-1

COMPARISON OF MASC AND ASTM ASH

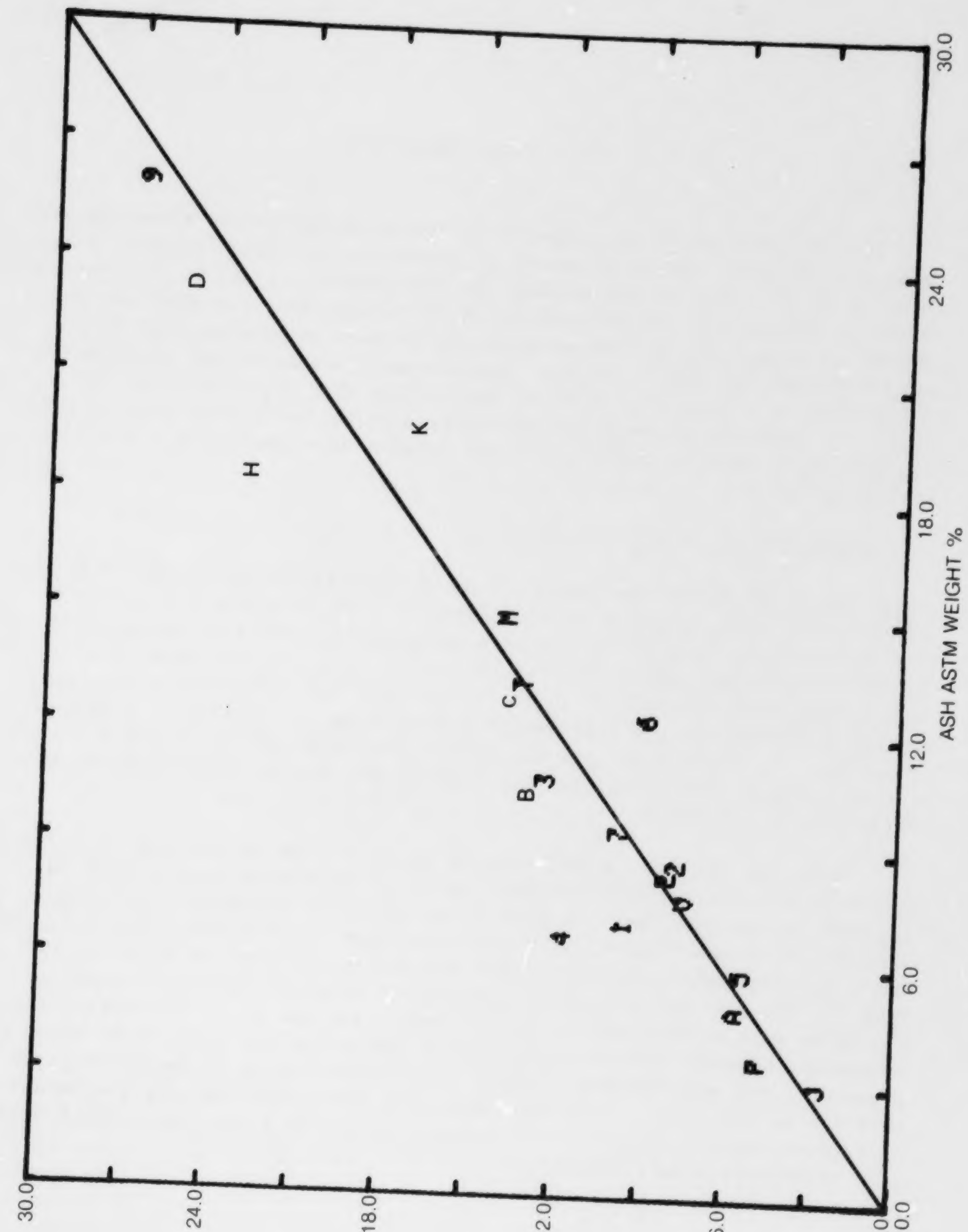


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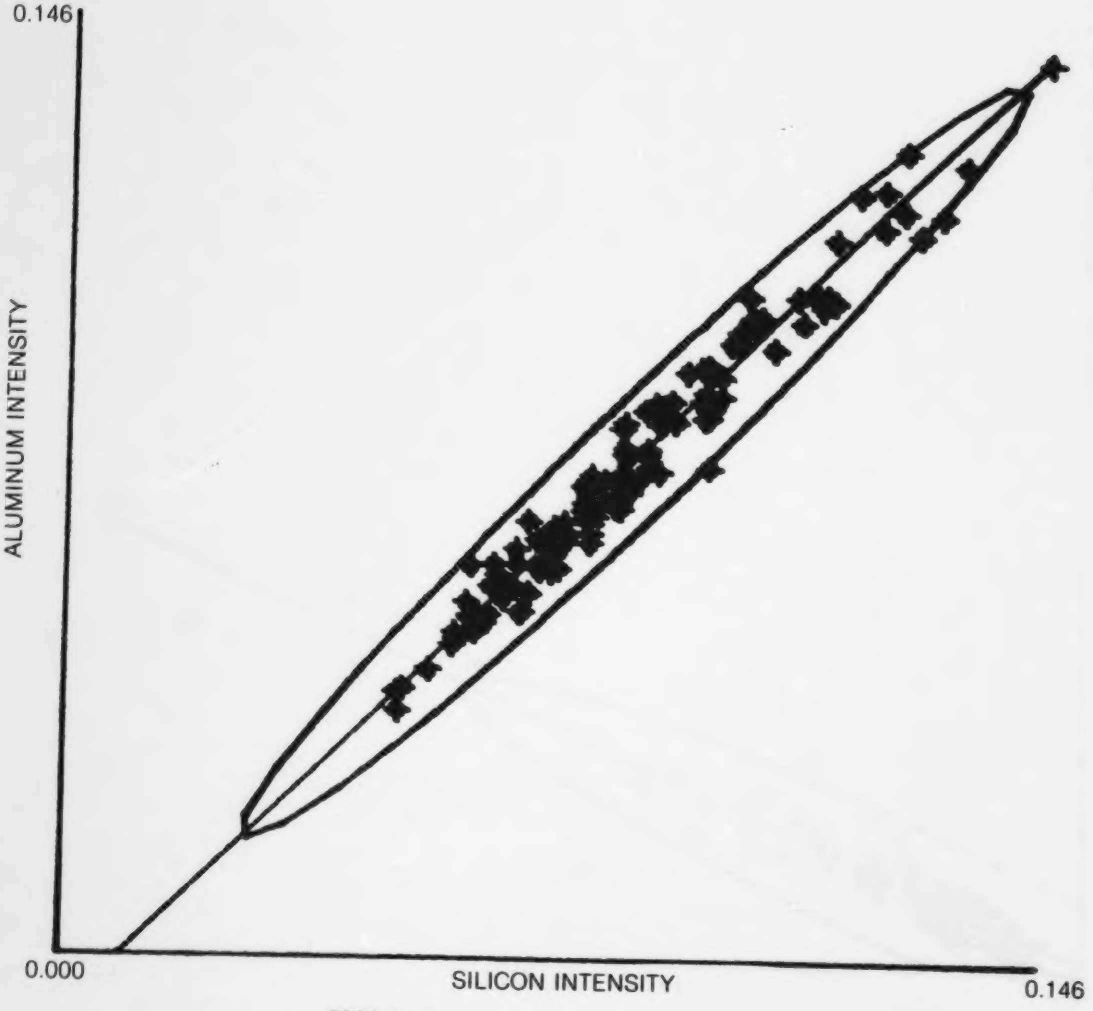
FIG. IV-2

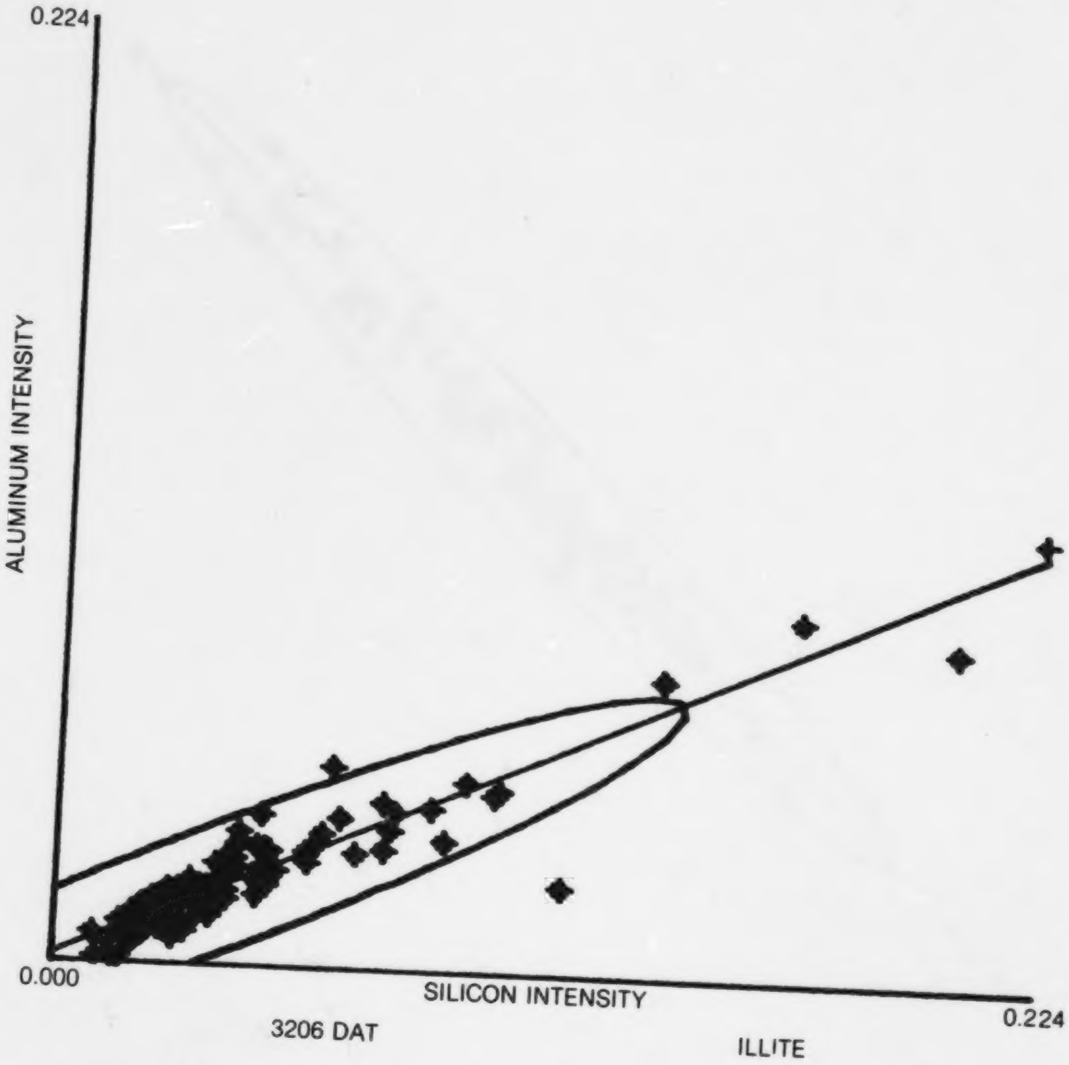
PSOC 212 COAL WITH 10% KAOLIN



79–10- 115--24

FIG. IV-3

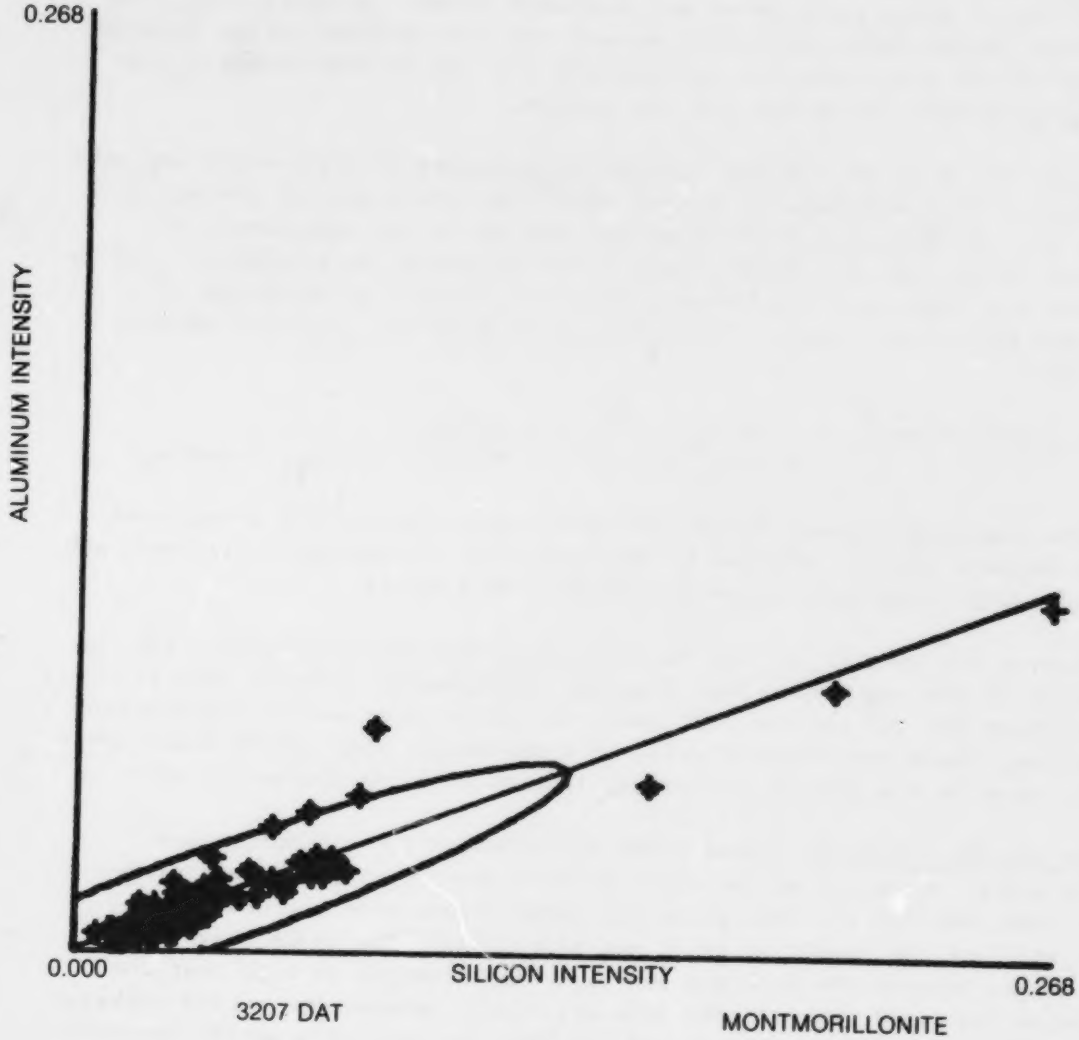
PSOC 212 COAL WITH 10% ILLITE



79–10–115–23

FIG. IV-4

PSOC 212 COAL WITH 10% MONTMORILLONITE



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V. MASC RESULTS ON EPA SUPPLIED COALS

The results of MASC measurements on the seven coals supplied by the EPA are summarized in Table V-1, V-2, and Appendix D. There are several interesting features of these coals which are discussed below. In particular, some of these coals showed less correlation between the iron and the sulfur k-ratios than most of the coals used for calibration, and one of them showed a high correlation between the sulfur and the calcium.

Table V-2 shows each of the mineral constituents of these coals and contains data on titanium, magnesium, and potassium, which are not discussed in Section IV. These data were obtained and reduced in the same manner as described in Section IV. These elements are assumed to be present in coal in the forms TiO_2, MgO, and K_2O and were measured relative to standards of Ti, Mg and KCl, respectively. This gives a relation for the total mineral matter of

$$\text{mm (wt. \% dry)} = \text{pyrite} + 1.38\,(k_{Al} + k_{Si} + 0.285\,k_{Ca} + 0.67\,k_{Fe}\,(\text{clay}) + 1.79\,k_{Ti} + 2.5\,k_{Mg} + 0.48\,k_K)$$

where the numerical factors inside the parentheses are the ZAF corrections for the assumed mineral relative to the reference standard actually used, and the 1.38 is the roughness factor discussed in Section IV.

Figures V-1 through V-7 are the MASC plots for the seven coals with the projection of the regression line from the multielement analysis onto the Fe-S plane shown for all but the 1635 coal, for which there was no correlation. In addition, where the analysis selected a reasonable clay-pyrite split, this line is shown on the plot as a vertical line parallel to the sulfur axis.

PHS 506,534,546,578,1632A These coals all appeared to be "conventional" pyritic coals. We accepted the split between iron bearing clay and pyrite for two of them (PHS 534 and 578) since the correlations were reasonable and consistent, and the resulting split was reasonable. The 1632A showed high correlations between the iron and the clay constituents; so high that the regression indicated that all the iron was clay. Because the pyrite correlation was also quite high, we rejected the clay in favor of a pyrite interpretation for the iron. A reasonable fraction of the iron in this sample should probably be attributed to clay (perhaps 20%).

TABLE V-1

SULFUR FORMS FOR EPA-SUPPLIED COALS (wt% dry)

	S(O)		S(M)		x in FeS_x
	MASC	ASTM	MASC	ASTM	MASC
1632A	0.4	-	1.0	-	1.8
1635	0.4	-	0.0	-	-
PHS 408	0.5	0.33	0.5*	0.34 Sulfate 0.11 Pyrite	1.1**
PHS 506	0.4	0.65	1.4	1.0	1.9
PHS 534	0.6	0.4	2.5	3.2	2.1
PHS 546	1.2	1.5	1.9	1.7	2.2
PHS 578	2.8	2.5	2.1	3.3	2.0

* This coal was mostly sulfate

** x in CaS_xO_4

TABLE V-2

MINERAL MATTER ANALYSES FOR EPA-SUPPLIED COALS (wt.% dry)

Coal	SiO_2		Al_2O_3		CaO*		TiO_2		MgO		K_2O		Fe_2O_3*		Total	
	MASC	HTA	MASC	HTA	MASC	HTA	MASC	HTA	MASC	HTA	MASC	HTA	MASC	HTA	MASC	HTA
1632A	14.6	-	7.2	-	0.2	-	0.3	-	0.0	-	0.6	-	1.25	-	24.2	-
1635	1.7	-	0.6	-	0.5	-	0.0	-	0.0	-	0.0	-	0.4	-	3.2	-
PHS 408	6.8		2.5		0.3		0.0		0.3		0.1		1.2		11.2	10.5
PHS 506	6.3	5.1	4.4	4.4	0.4	0.4	0.0	0.2	0.3	0.3	0.3	0.2	1.8	1.8	13.5	12.8
PHS 534	12.4	10.0	7.6	6.6	0.1	0.1	0.0	0.2	0.0	0.2	0.9	0.8	3.4	4.6	24.4	22.9
PHS 546	12.7	9.6	6.5	5.0	0.1	0.1	0.3	0.3	0.0	0.1	0.5	0.4	2.4	2.7	22.5	18.6
PHS 578	8.8	8.3	4.0	4.1	0.5	0.7	0.0	0.2	0.0	0.2	0.3	0.4	3.0	4.9	16.6	19.6

* CaO for MASC calculated from .56*$CaCO_3$ (MASC)

** Fe_2O_3 for MASC calculated from 1.25* $S(M)_{MASC}$ + Fe_2O_3 (MASC)

FIG. V-1

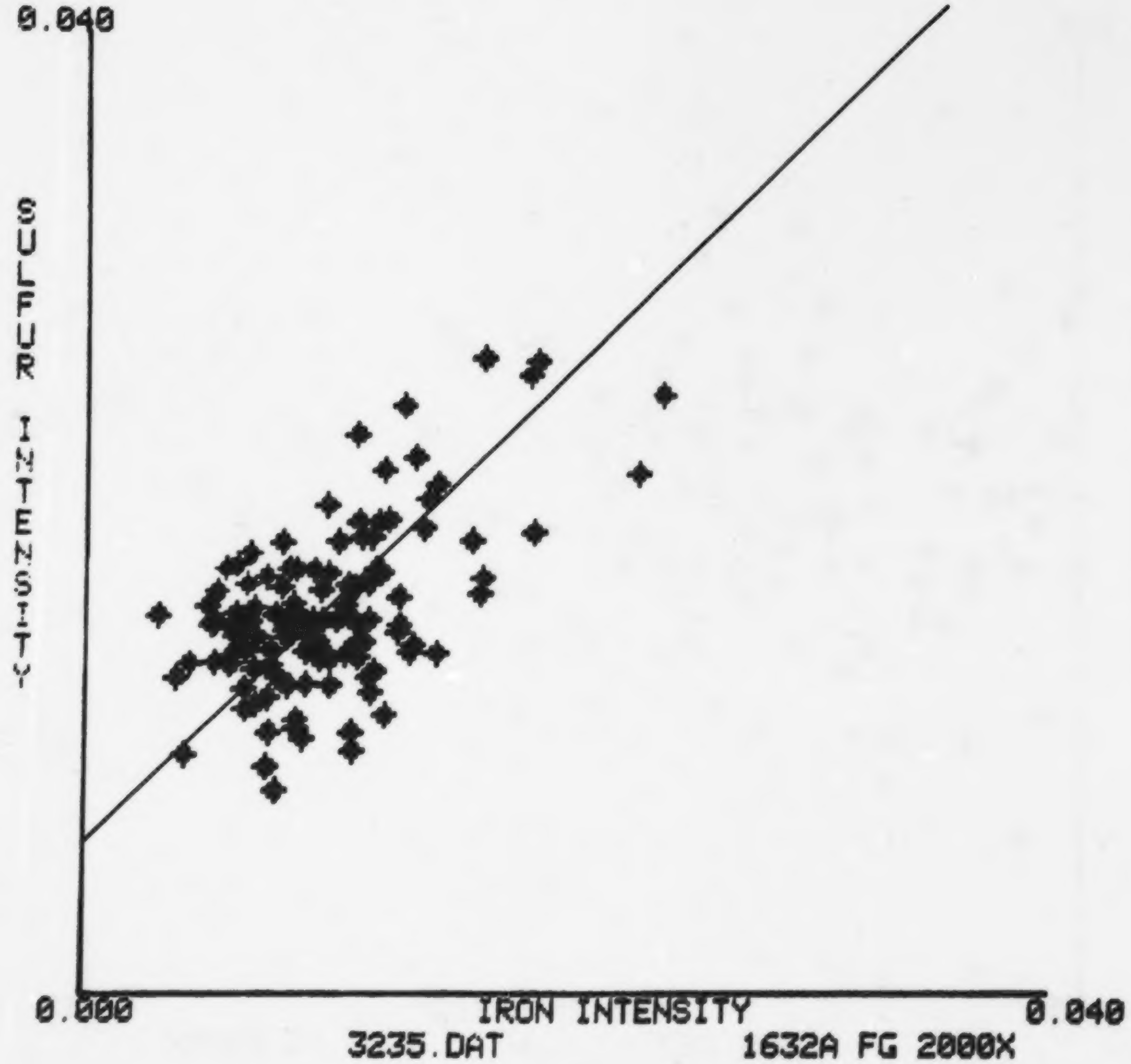

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FIG. V-2

1635 COAL MASC PLOT

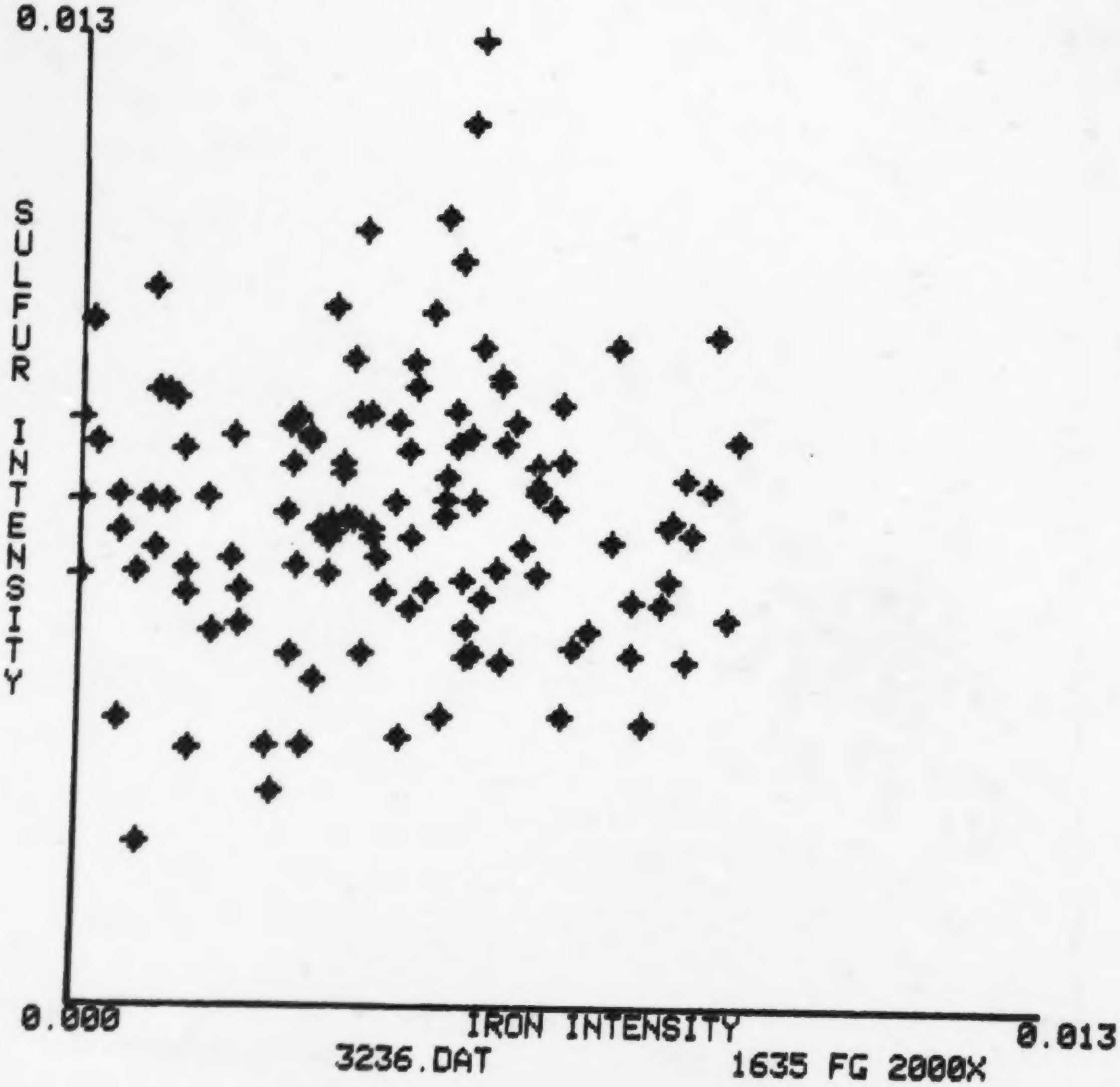

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FIG. V-3

PHS 408 COAL MASC PLOT

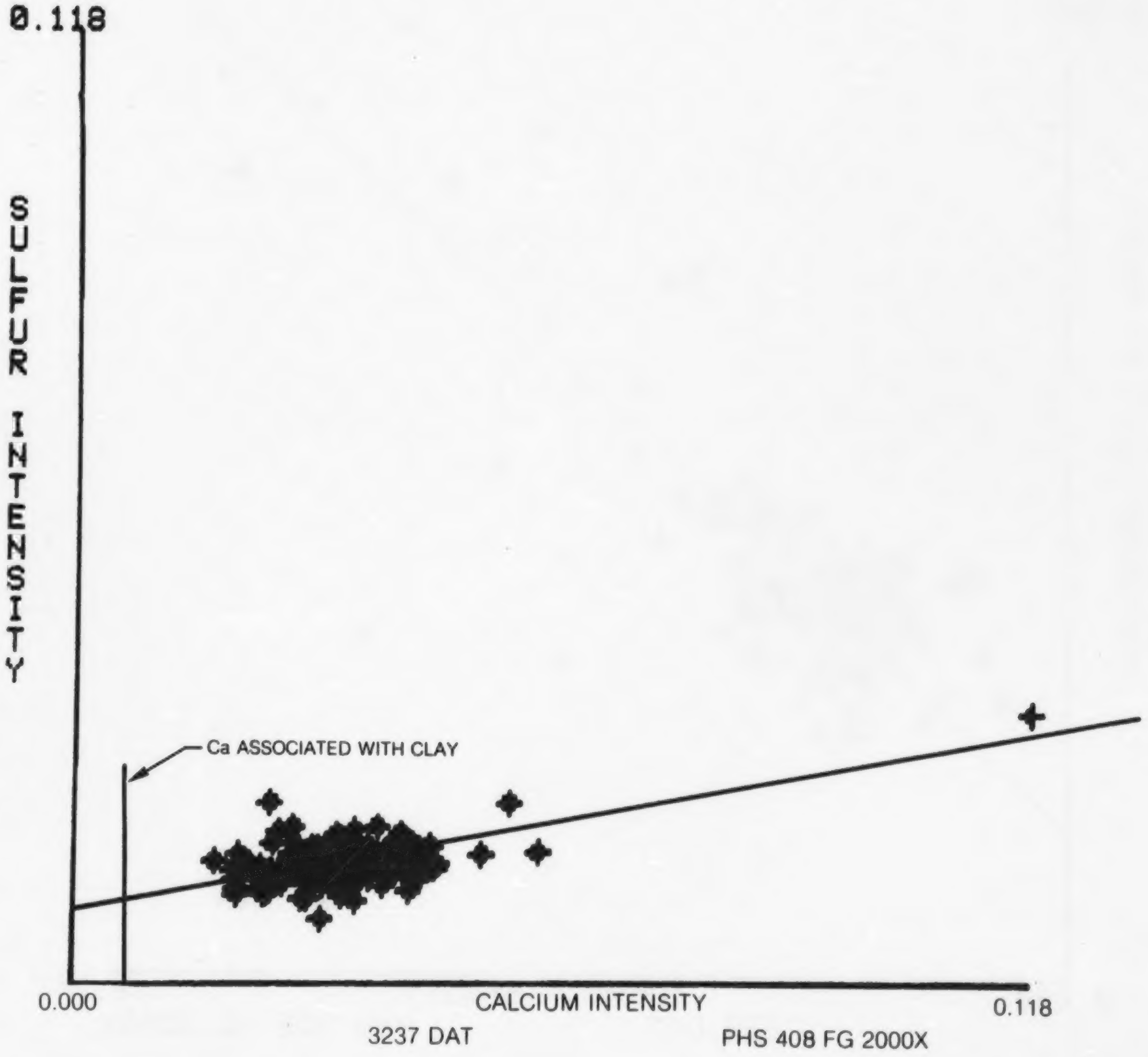

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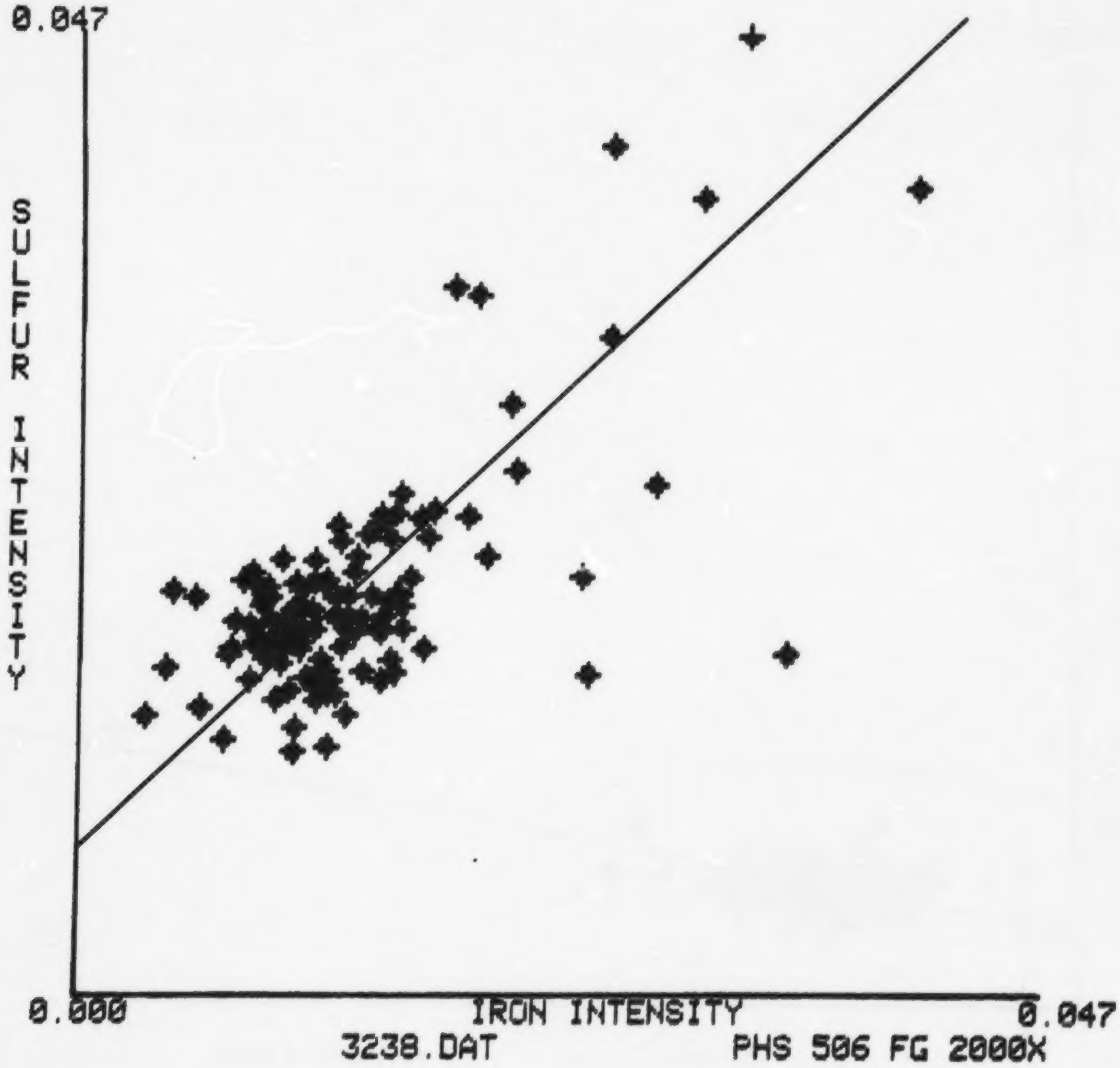
FIG. V-4

PHS 506 COAL MASC PLOT



79-10-115-17

FIG. V-5

PHS 534 COAL MASC PLOT

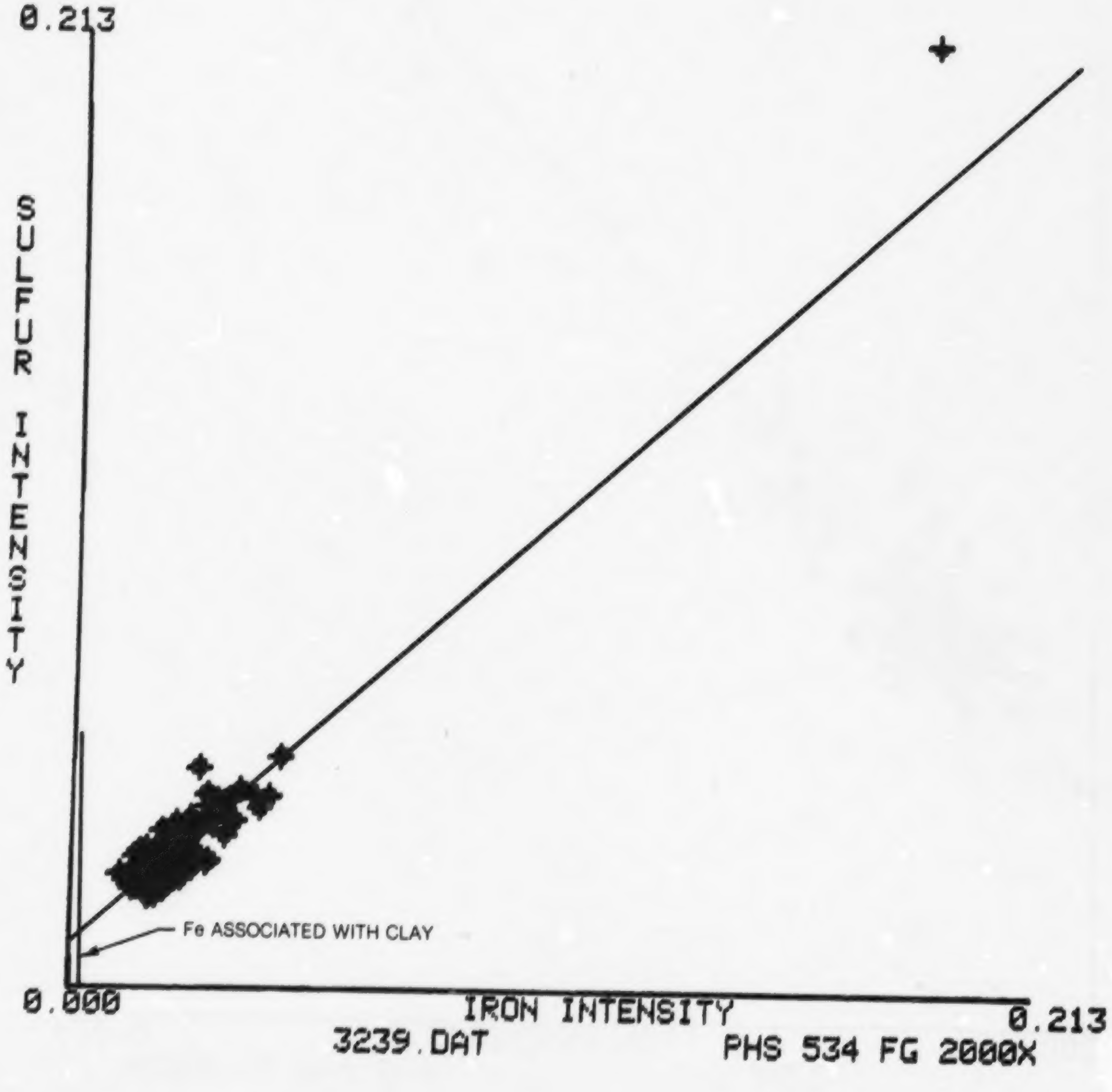


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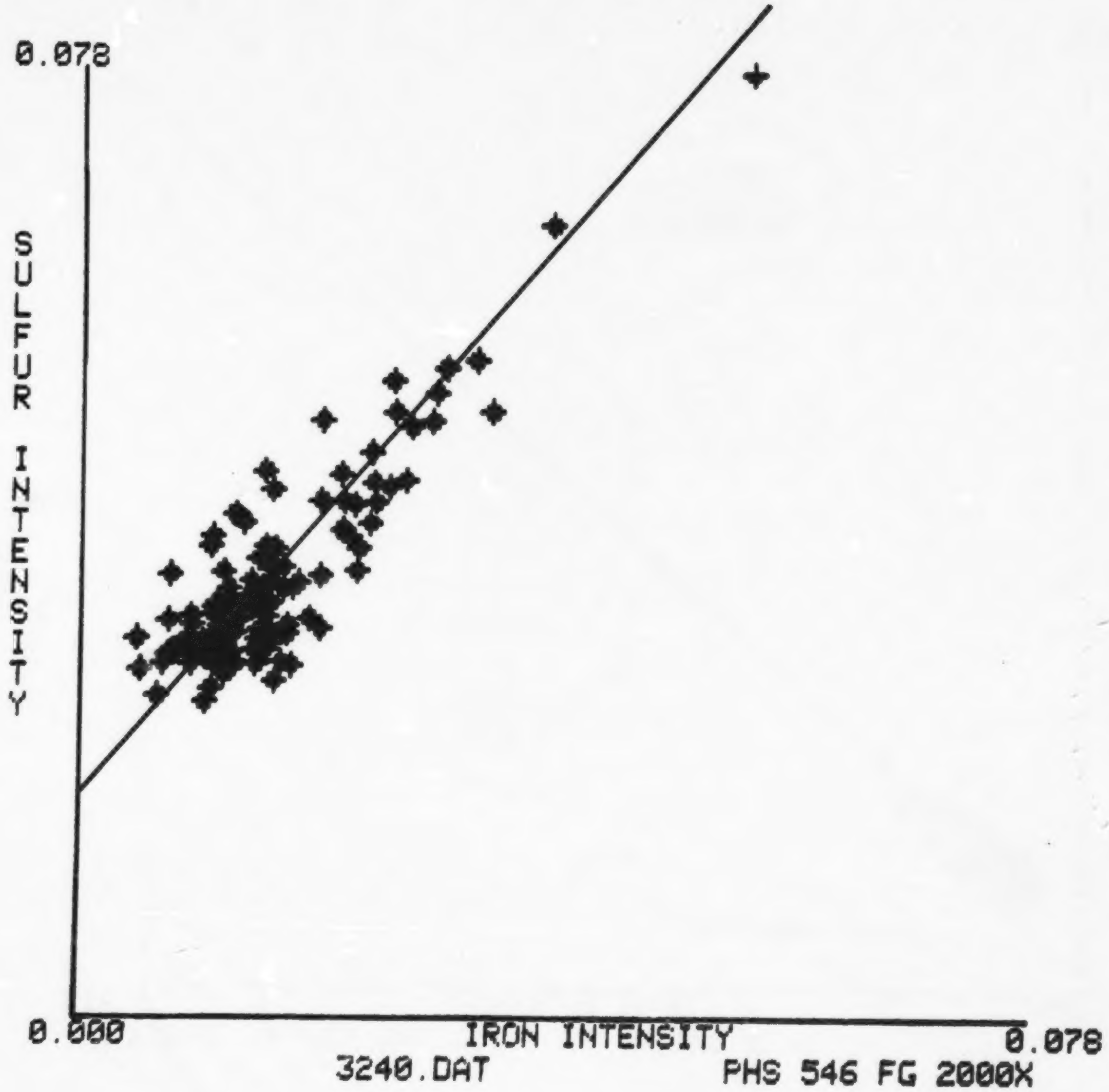
FIG. V-6

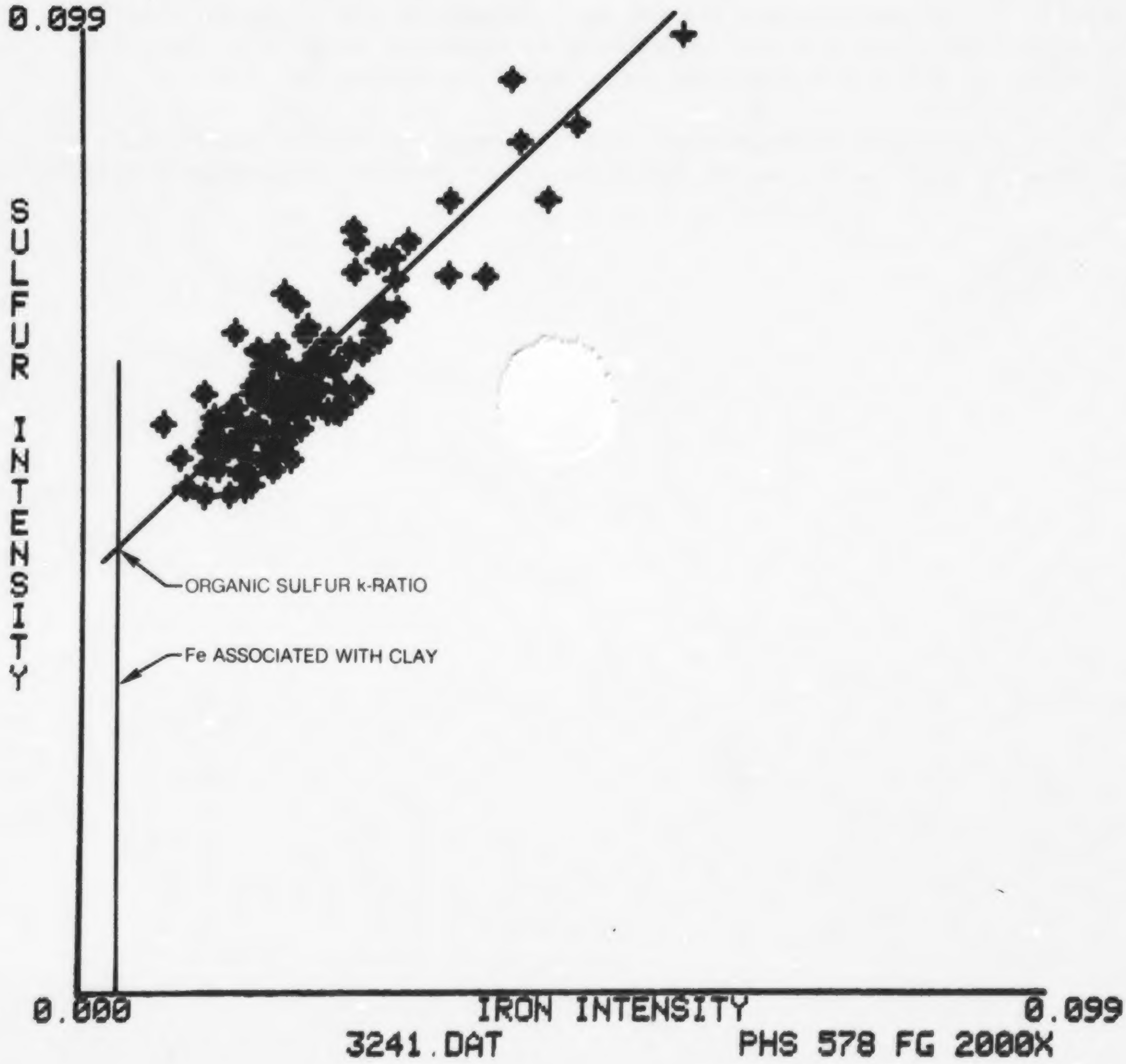
PHS 546 COAL MASC PLOT



79-10-115-19

FIG. V-7

PHS 578 COAL MASC PLOT



79-10-115-20

PHS 408 This is the only coal we have yet studied that had a clearly significant correlation between the sulfur and the calcium, and as such we have no reliable calibration for converting this data to weight percent. The organic sulfur is calculated as usual. For the calcium sulfur, we assumed that it was present in the form of $CaSO_4$, scaled up the k-ratio by the 1.38 "roughness" factor, and then used MAGIC to convert the k-ratio to weight percent. We have chosen to accept the split between sulfate and clay calcium determined by the regression because although the correlations are small, they are consistent, and the result is plausible. In addition, the final weight percents of the constituents are not much changed by rejecting the clay fit. The stoichiometry of the calcium sulfate is estimated to be $CaS_{1.1}O_x$ using the slope of the S-Ca regression, using MAGIC to correct the slope.

1635 None of the correlations for this coal were considered significant; so the five elements were treated independently as minerals plus organic sulfur.

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APPENDIX A

CORRELATIONS AND EIGEVECTORS FOR CALIBRATION COALS

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103 FG 2000X                    3251.DAT

                           CORRELATIONS

       MEAN     SIGMA     FE       S        SI       AL       CA

 FE   0.1865  0.1764  1.0000  0.0643 -0.1631 -0.0428 -0.0339
 S    1.1367  0.1934  0.0643  1.0000  0.0118 -0.0681  0.1177
 SI   2.1250  0.5187 -0.1631  0.0118  1.0000  0.3962 -0.0411
 AL   1.3900  0.2334 -0.0428 -0.0681  0.3962  1.0000 -0.0644
 CA   0.7088  0.5820 -0.0339  0.1177 -0.0411 -0.0644  1.0000

EIGENVECTORS

  VALUE       FE          S          SI          AL          CA
   1.4643    0.3029     0.1615    -0.6649    -0.6421     0.1667
   1.1053   -0.1706     0.6667     0.2190     0.0397     0.6905
   1.0050   -0.8062    -0.4236    -0.1205    -0.2933     0.2649
   0.8515    0.4192    -0.5673    -0.0497     0.2756     0.6512
   0.5739   -0.2314     0.1679    -0.7021     0.6513    -0.0341

   REGRESSIONS


S  =  0.9098 +  0.3209CA + -0.0003SI

ORGANIC S=      0.910  MINERAL S=      0.227
```

```
170 FG 2000X                     3252.DAT

                               CORRELATIONS

       MEAN      SIGMA     FE        S         SI        AL        CA

FE    1.1590    0.7125    1.0000    0.8285    0.0435    0.0165   -0.0320
S     3.8829    0.6519    0.8285    1.0000    0.1154    0.0059   -0.0712
SI    2.2316    0.6349    0.0435    0.1154    1.0000    0.4119   -0.0509
AL    1.4943    0.2563    0.0165    0.0059    0.4119    1.0000    0.0714
CA    1.9890    0.8485   -0.0320   -0.0712   -0.0509    0.0714    1.0000

EIGENVECTORS

  VALUE        FE          S           SI          AL          CA
  1.8572     0.6849      0.6940      0.1800      0.0973     -0.0858
  1.3962    -0.1493     -0.1181      0.6759      0.7081      0.0741
  1.0089     0.1074      0.0459     -0.1718      0.0924      0.9738
  0.5715     0.0908     -0.0321     -0.6886      0.6916     -0.1956
  0.1662    -0.6991      0.7080     -0.0838      0.0481      0.0244

   REGRESSIONS

S  =  2.6425 +  0.9211FE +  0.1156AL
FE(CLAY) =  0.0000  FE(PYRT) =  1.1590

ORGANIC S=       2.642  MINERAL S=       1.240
```

```
212 FG 2000X                    3253.DAT
                               CORRELATIONS
      MEAN      SIGMA     FE        S        SI       AL       CA

 FE   0.2725   0.3269   1.0000   0.0226   0.1710   0.0097   0.1740
 S    1.1911   0.2136   0.0226   1.0000  -0.0045  -0.0785  -0.0959
 SI   0.9670   0.2327   0.1710  -0.0045   1.0000   0.6558   0.1631
 AL   0.7329   0.2230   0.0097  -0.0785   0.6558   1.0000  -0.0009
 CA   0.4744   0.4172   0.1740  -0.0959   0.1631  -0.0009   1.0000

EIGENVECTORS

  VALUE        FE        S          SI         AL         CA
   1.7193    0.2238   -0.0972    0.6908     0.6432     0.2229
   1.1521    0.6120   -0.1521   -0.1087    -0.3553     0.6814
   1.0292    0.3798    0.9059    0.1003    -0.0512    -0.1496
   0.7920    0.6447   -0.3727   -0.0593     0.0135    -0.6646
   0.3074    0.1246    0.0885   -0.7053     0.6763     0.1479

    REGRESSIONS


S  =  1.2787 + -0.1828FE + -0.0515AL
FE(CLAY) =  0.0000  FE(PYRT) =  0.2725

ORGANIC S=       1.191  MINERAL S=      0.000
```

```
330 FG 2000X
                                 3254.DAT
                             CORRELATIONS
        MEAN      SIGMA     FE        S        SI       AL       CA

FE     2.1891    0.8412   1.0000   0.8798  -0.0713   0.0141   0.0387
S      2.7982    0.7875   0.8798   1.0000  -0.1199  -0.0363  -0.0362
SI     1.4215    0.2234  -0.0713  -0.1199   1.0000   0.5453   0.0718
AL     1.0293    0.1999   0.0141  -0.0363   0.5453   1.0000   0.0523
CA     0.3702    0.3525   0.0387  -0.0362   0.0718   0.0523   1.0000

EIGENVECTORS

 VALUE       FE        S         SI        AL        CA
  1.9162   0.6708    0.6829   -0.2393   -0.1607   -0.0266
  1.5303   0.2276    0.1722    0.6537    0.6822    0.1606
  0.9885   0.0226   -0.0492   -0.0954   -0.1355    0.9847
  0.4493  -0.0381   -0.0461   -0.7113    0.6998    0.0259
  0.1156  -0.7045    0.7068    0.0188    0.0253    0.0567

    REGRESSIONS


S  =  1.0793 +  0.9349FE + -0.3184AL
FE(CLAY) =  0.3506  FE(PYRT) =  1.8385

ORGANIC S=       1.079  MINERAL S=      1.719
```

```
268 FG 2000X
                                    3255.DAT
                              CORRELATIONS
      MEAN      SIGMA     FE        S        SI        AL        CA
FE   0.9269    0.3478   1.0000   0.4453   0.1107  -0.0333  -0.1415
S    1.8528    0.3650   0.4453   1.0000   0.0725  -0.0451   0.0270
SI   5.1845    0.5657   0.1107   0.0725   1.0000   0.5873   0.1064
AL   3.3307    0.3186  -0.0333  -0.0451   0.5873   1.0000   0.0462
CA   0.6307    0.4352  -0.1415   0.0270   0.1064   0.0462   1.0000
EIGENVECTORS

 VALUE       FE        S         SI        AL        CA
 1.6166    0.1850    0.1739    0.6998    0.6539    0.1349
 1.4661    0.6843    0.6516   -0.0816   -0.2358   -0.2120
 1.0026   -0.0654    0.2950   -0.0552   -0.1932    0.9318
 0.5271   -0.6705    0.6764   -0.1031    0.1680   -0.2325
 0.3876    0.2090   -0.0249   -0.7000    0.6718    0.1203

  REGRESSIONS


S  =  0.9371 +  0.9989FE + -0.0020SI
FE(CLAY) =  0.0101  FE(PYRT) =  0.9168

ORGANIC S=      0.937  MINERAL S=      0.916
```

```
308 FG 2000X
                                       3256.DAT
                                   CORRELATIONS
      MEAN       SIGMA      FE        S         SI        AL        CA
FE    2.6031    1.6598   1.0000   0.9528  -0.0629  -0.0496  -0.1531
S     4.5912    1.7268   0.9528   1.0000  -0.0434  -0.0092  -0.1229
SI    2.6495    0.5889  -0.0629  -0.0434   1.0000   0.6768   0.0933
AL    2.0897    0.4067  -0.0496  -0.0092   0.6768   1.0000  -0.1117
CA    0.4557    0.4188  -0.1531  -0.1229   0.0933  -0.1117   1.0000

EIGENVECTORS

 VALUE        FE          S          SI          AL          CA
  2.0113     0.6791     0.6716    -0.1827     -0.1412     -0.1857
  1.6601     0.1408     0.1649     0.6782      0.6969     -0.0854
  0.9891     0.1284     0.1578     0.1714     -0.1127      0.9574
  0.2942    -0.0348     0.0486    -0.6904      0.6921      0.2017
  0.0454    -0.7080     0.7032     0.0247     -0.0512     -0.0314

    REGRESSIONS

S  =  1.5803 +  1.0364FE +  0.1498AL
FE(CLAY) =  0.0000  FE(PYRT) =  2.6031

ORGANIC S=      1.580  MINERAL S=      3.011
```

```
40659 FG 2000X                     3257.DAT

                               CORRELATIONS
       MEAN      SIGMA     FE       S       SI       AL       CA

FE    4.0692   1.1040   1.0000   0.8764  -0.1104  -0.0308   0.0196
S     6.1172   0.9732   0.8764   1.0000  -0.1182  -0.0828   0.0568
SI    8.9316   1.0943  -0.1104  -0.1182   1.0000   0.5744  -0.0423
AL    4.9426   0.4670  -0.0308  -0.0828   0.5744   1.0000  -0.0644
CA    0.8440   0.4383   0.0196   0.0568  -0.0423  -0.0644   1.0000

EIGENVECTORS

  VALUE        FE         S         SI         AL         CA
   1.9621    0.6345    0.6452    -0.3175    -0.2709     0.0831
   1.5027    0.3138    0.2832     0.6201     0.6545    -0.0918
   0.9902   -0.0440   -0.0061     0.1069     0.0615     0.9914
   0.4242    0.0201   -0.0786    -0.7085     0.7003     0.0333
   0.1207   -0.7047    0.7052    -0.0365     0.0636    -0.0269

    REGRESSIONS


S  =  3.0091 +  0.8792FE + -0.0950AL
FE(CLAY) =  0.5341  FE(PYRT) =  3.5351

ORGANIC S=       3.009  MINERAL S=      3.108
```

```
LIG FG 2000X                    3258.DAT

                            CORRELATIONS

      MEAN      SIGMA    FE       S        SI       AL       CA

 FE   0.3317  0.2656  1.0000  0.3890  0.0985  0.0734  0.1162
 S    1.0067  0.2637  0.3890  1.0000 -0.0277  0.1885 -0.0322
 SI   3.1605  0.9881  0.0985 -0.0277  1.0000  0.4538 -0.0577
 AL   2.2769  0.3000  0.0734  0.1885  0.4538  1.0000  0.0011
 CA   9.1987  0.8759  0.1162 -0.0322 -0.0577  0.0011  1.0000

EIGENVECTORS

  VALUE       FE        S         SI        AL        CA
   1.5946    0.4569    0.4586    0.4948    0.5794    0.0175
   1.2798   -0.5227   -0.4983    0.5204    0.3702   -0.2656
   1.0077    0.0347   -0.3277    0.1298    0.0930    0.9305
   0.6853   -0.6053    0.4488   -0.4160    0.4716    0.1915
   0.4325    0.3877   -0.4823   -0.5426    0.5442   -0.1630

   REGRESSIONS

S  =  0.6644 +  0.9704FE +  0.0065SI
FE(CLAY) =  0.0000  FE(PYRT) =  0.3317

ORGANIC S=      0.664  MINERAL S=      0.342
```

```
ISGS VF 2000X                    3098.DAT

                           CORRELATIONS

      MEAN      SIGMA     FE        S         SI        AL        CA

FE    1.5858   1.0852   1.0000   0.9134   0.0607   0.1612  -0.0555
S     4.8781   1.0296   0.9134   1.0000  -0.0224   0.1434  -0.0292
SI    2.2751   0.5867   0.0607  -0.0224   1.0000   0.5686  -0.0221
AL   16.9510   3.0325   0.1612   0.1434   0.5686   1.0000  -0.0431
CA    3.4532  18.3997  -0.0555  -0.0292  -0.0221  -0.0431   1.0000

EIGENVECTORS

 VALUE        FE         S          SI         AL         CA
  1.9995    0.6575     0.6444     0.2097     0.3210    -0.0738
  1.5027   -0.2416    -0.2904     0.6867     0.6199    -0.0398
  0.9942    0.0270     0.0501     0.0548     0.0372     0.9962
  0.4222   -0.1305     0.0032    -0.6880     0.7137     0.0146
  0.0815   -0.7011     0.7056     0.0902    -0.0439    -0.0198

   REGRESSIONS


S  =  3.6503 +  0.9511FE + -0.1233SI
FE(CLAY) =  0.2949  FE(PYRT) =  1.2909

ORGANIC S=       3.650  MINERAL S=       1.228
```

```
SCRANTON FG 2000X                3242.DAT

                           CORRELATIONS

     MEAN      SIGMA     FE       S        SI       AL       CA

FE   0.7937   0.3265   1.0000   0.2909  -0.0363   0.3007   0.0331
S    2.3054   0.2915   0.2909   1.0000  -0.1601  -0.0509  -0.0798
SI   1.3793   1.2893  -0.0363  -0.1601   1.0000   0.0526  -0.0990
AL   0.8228   0.7003   0.3007  -0.0509   0.0526   1.0000  -0.1446
CA   9.3264   0.8369   0.0331  -0.0798  -0.0990  -0.1446   1.0000

EIGENVECTORS

 VALUE       FE          S          SI          AL          CA
  1.4205    0.6863     0.5090    -0.1554      0.4670     -0.1665
  1.2248   -0.0143    -0.4074     0.6102      0.5068     -0.4523
  0.9934    0.2914    -0.4389     0.0156      0.3340      0.7814
  0.8534    0.2458     0.3535     0.7665     -0.3982      0.2618
  0.5079   -0.6192     0.5073     0.1253      0.5049      0.2975

   REGRESSIONS


S   =  1.6726 +  1.1287FE + -0.3197AL
FE(CLAY) =  0.2330  FE(PYRT) =  0.5607

ORGANIC S=       1.673  MINERAL S=      0.633
```

```
BEULAH FG 2000X                    3243.DAT

                              CORRELATIONS
        MEAN      SIGMA     FE        S         SI        AL        CA
FE     2.5031    0.6210    1.0000    0.7201   -0.0885   -0.0731    0.0002
S      2.7246    0.5853    0.7201    1.0000    0.0374   -0.0609    0.0483
SI     0.9061    0.4677   -0.0885    0.0374    1.0000    0.4147    0.0236
AL     0.4865    0.2081   -0.0731   -0.0609    0.4147    1.0000   -0.0209
CA     5.7597    0.7755    0.0002    0.0483    0.0236   -0.0209    1.0000

EIGENVECTORS

 VALUE       FE          S          SI          AL          CA
  1.7490    0.6872     0.6728    -0.1649     -0.2143      0.0444
  1.3936    0.1447     0.2319     0.6933      0.6659      0.0347
  1.0022   -0.0746    -0.0034     0.0361     -0.0720      0.9939
  0.5907    0.1422    -0.0929    -0.6816      0.7065      0.0863
  0.2646   -0.6935     0.6964    -0.1623      0.0792     -0.0381

    REGRESSIONS

S  =  0.2044 +  0.9507FE +  0.1551SI
FE(CLAY) =  0.0000  FE(PYRT) =  2.5031

ORGANIC S=      0.204  MINERAL S=      2.520
```

```
MONT SAVAGE FG 2000X          3244.DAT

                        CORRELATIONS

     MEAN      SIGMA    FE       S        SI       AL       CA

FE   0.1283  0.1525  1.0000  0.1173  0.0292  0.1238 -0.1218
S    0.7837  0.1798  0.1173  1.0000 -0.1001  0.0641  0.0641
SI   0.6129  0.2387  0.0292 -0.1001  1.0000  0.4854 -0.0009
AL   0.5053  0.2092  0.1238  0.0641  0.4854  1.0000  0.1697
CA   9.8343  0.9503 -0.1218  0.0641 -0.0009  0.1697  1.0000

EIGENVECTORS

  VALUE       FE        S         SI        AL        CA
   1.5268   0.1634   0.0210    0.6581    0.7091    0.1921
   1.1442   0.7427   0.5583   -0.1343    0.0299   -0.3432
   1.0994  -0.1672   0.5998   -0.2750    0.0788    0.7283
   0.7726  -0.6100   0.5551    0.2433    0.0362   -0.5092
   0.4570  -0.1471  -0.1415   -0.6434    0.6991   -0.2358

    REGRESSIONS

S  =  0.7321 +  0.8931FE + -0.1246AL
FE(CLAY) =  0.0705  FE(PYRT) =  0.0578

ORGANIC S=      0.732  MINERAL S=      0.052
```

```
UPPER CLIFF FG 2000S           3245.DAT

                        CORRELATIONS

      MEAN      SIGMA     FE       S        SI       AL       CA

FE   1.0900   0.3358   1.0000   0.4576   0.3087   0.1102  -0.0493
S    1.5137   0.2644   0.4576   1.0000   0.1183   0.0621  -0.1000
SI   3.7549   0.4423   0.3087   0.1183   1.0000   0.4122   0.0309
AL   2.4710   0.2893   0.1102   0.0621   0.4122   1.0000   0.0523
CA   0.4624   0.4302  -0.0493  -0.1000   0.0309   0.0523   1.0000

EIGENVECTORS

 VALUE       FE         S         SI        AL        CA
  1.7510    0.5692    0.4712    0.5317    0.4109   -0.0496
  1.2212   -0.3069   -0.4891    0.3869    0.5424    0.4719
  0.9357    0.2402    0.2433   -0.1671   -0.2895    0.8783
  0.6246    0.3443   -0.5015    0.5278   -0.5908   -0.0495
  0.4675   -0.6368    0.4776    0.5110   -0.3227    0.0328

  REGRESSIONS


S  =  1.3075 +  0.8266FE + -0.2812AL
FE(CLAY) =  0.8406  FE(PYRT) =  0.2494

ORGANIC S=      1.308  MINERAL S=      0.206
```

```
ROSA FG 2000X                         3246.DAT

                                  CORRELATIONS

         MEAN       SIGMA      FE        S         SI        AL        CA

 FE     4.6559     2.2331    1.0000    0.6845   -0.0197   -0.0582   -0.0387
 S      3.7536     1.4855    0.6845    1.0000   -0.0735   -0.0866    0.0922
 SI     2.9054     2.2528   -0.0197   -0.0735    1.0000    0.5901    0.0398
 AL     1.1911     0.3171   -0.0582   -0.0866    0.5901    1.0000   -0.0404
 CA     0.2970     0.3170   -0.0387    0.0922    0.0398   -0.0404    1.0000

EIGENVECTORS

 VALUE        FE          S           SI          AL          CA
  1.7675     0.5719      0.5981     -0.3832     -0.4078      0.0446
  1.5112     0.4129      0.3765      0.5965      0.5749      0.0377
  1.0148    -0.1333      0.0492      0.0600     -0.0633      0.9860
  0.4083    -0.1229      0.1494     -0.6862      0.6984      0.0625
  0.2982    -0.6852      0.6897      0.1510     -0.1069     -0.1431

   REGRESSIONS


S  =  0.7672 +  0.6675FE + -0.0417SI
FE(CLAY) =  0.1817  FE(PYRT) =  4.4742

ORGANIC S=        0.767  MINERAL S=       2.986
```

```
BLK CREEK FG 2000X                  3247.DAT
                               CORRELATIONS
        MEAN      SIGMA    FE       S        SI       AL       CA
FE     0.2954    0.2038   1.0000   0.1807   0.0537   0.0607   0.0831
S      1.1142    0.2418   0.1807   1.0000   0.1269   0.0647   0.1452
SI     1.5357    0.2810   0.0537   0.1269   1.0000   0.7579   0.1075
AL     1.1756    0.2437   0.0607   0.0647   0.7579   1.0000   0.0613
CA     0.3471    0.3538   0.0831   0.1452   0.1075   0.0613   1.0000

EIGENVECTORS

 VALUE       FE        S         SI        AL        CA
 1.8280    0.1599    0.2232    0.6731    0.6595    0.1914
 1.2099    0.5674    0.5987   -0.2061   -0.2623    0.4565
 0.9189   -0.5837   -0.0876   -0.0047   -0.0577    0.8052
 0.8049   -0.5579    0.7621    0.0179   -0.0466   -0.3247
 0.2383   -0.0233    0.0576   -0.7100    0.7006    0.0354

   REGRESSIONS

S  =  0.6458 +  1.2925FE +  0.0736AL
FE(CLAY) =  0.0000  FE(PYRT) =  0.2954

ORGANIC S=      0.646  MINERAL S=      0.468
```

```
TRW FG 2000X                        3248.DAT

                              CORRELATIONS

      MEAN     SIGMA     FE       S        SI       AL       CA

FE   0.3744   0.2228   1.0000   0.2231   0.0597  -0.0939  -0.1327
S    1.3592   0.2283   0.2231   1.0000   0.0010  -0.0685   0.0128
SI   3.4360   0.5957   0.0597   0.0010   1.0000   0.6519   0.0617
AL   2.4947   0.3857  -0.0939  -0.0685   0.6519   1.0000  -0.0118
CA   0.7354   0.4520  -0.1327   0.0128   0.0617  -0.0118   1.0000

EIGENVECTORS

 VALUE       FE        S         SI        AL        CA
  1.6611   -0.0845   -0.0992    0.6938    0.7051    0.0672
  1.2548    0.7160    0.6044    0.1728    0.0296   -0.3021
  1.0177   -0.0375    0.4698    0.0577   -0.0787    0.8765
  0.7440   -0.6696    0.6356   -0.0861    0.1275   -0.3522
  0.3224    0.1744    0.0115   -0.6915    0.6924    0.1090

   REGRESSIONS


S  =  1.0832 +  0.8746FE + -0.0150SI
FE(CLAY) =  0.0588  FE(PYRT) =  0.3156

ORGANIC S=      1.083  MINERAL S=      0.276
```

```
UTAH FG 2000X                          3249.DAT

                                CORRELATIONS

        MEAN        SIGMA     FE         S         SI        AL        CA

   FE    0.2836   0.2041   1.0000   0.1410   0.0216   0.0937  -0.0304
   S     1.0420   0.2006   0.1410   1.0000   0.0016  -0.0430  -0.0490
   SI    3.3745   2.0787   0.0216   0.0016   1.0000   0.6934  -0.0653
   AL    1.8197   0.3999   0.0937  -0.0430   0.6934   1.0000  -0.0462
   CA    1.0055   0.5104  -0.0304  -0.0490  -0.0653  -0.0462   1.0000

EIGENVECTORS

  VALUE          FE          S           SI          AL          CA
   1.7123      0.1160     -0.0099      0.6953      0.7001     -0.1134
   1.1546      0.6437      0.6985     -0.0782     -0.0669     -0.2950
   0.9788      0.3333      0.0972      0.0209      0.0768      0.9344
   0.8543     -0.6735      0.7062      0.1448      0.0043      0.1632
   0.3000     -0.0861      0.0611     -0.6993      0.7068     -0.0180

    REGRESSIONS


S  =  0.9192 +  1.0470FE + -0.0957AL
FE(CLAY) =  0.1663  FE(PYRT) =  0.1173

ORGANIC S=       0.919  MINERAL S=       0.123
```

APPENDIX B

CORRELATIONS AND EIGENVECTORS FOR WASHED COALS

```
308 1.4FL GRD                        3172.DAT

                               CORRELATIONS
        MEAN      SIGMA     FE        S         SI        AL        CA
FE    2.0969    0.7089    1.0000    0.7020    0.0951    0.0669    0.0916
S     3.9520    0.5765    0.7020    1.0000    0.1043    0.0233    0.0012
SI    2.7599    0.3521    0.0951    0.1043    1.0000    0.3418    0.0827
AL    1.8256    0.2713    0.0669    0.0233    0.3418    1.0000    0.1249
CA    0.5681    0.4379    0.0916    0.0012    0.0827    0.1249    1.0000

EIGENVECTORS

  VALUE         FE          S          SI          AL          CA
  1.7715      0.6577     0.6438     0.2838      0.2258      0.1461
  1.3315     -0.2487    -0.2985     0.5778      0.6440      0.3170
  0.9531      0.0563    -0.0644    -0.3210     -0.1761      0.9266
  0.6532      0.0787     0.0020    -0.6934      0.7077     -0.1103
  0.2907     -0.7044     0.7016    -0.0422      0.0485      0.0861

    REGRESSIONS


S  =  2.5310 +  0.8171FE + -0.1602AL
FE(CLAY) =  0.3579  FE(PYRT) =  1.7390

ORGANIC S=       2.531  MINERAL S=       1.421
```

```
308 FL FG 100 1.4SG              3204 DAT

                         CORRELATIONS

      MEAN      SIGMA     FE        S         SI        AL        CA

FE    2.7110   0.4918   1.0000   0.6370  -0.0192  -0.0287  -0.0336
S     4.6309   0.4840   0.6370   1.0000  -0.1407  -0.1170   0.0101
SI    2.5894   0.3436  -0.0192  -0.1407   1.0000   0.4254   0.0807
AL    2.3991   0.2529  -0.0287  -0.1170   0.4254   1.0000   0.0392
CA    0.5453   0.4508  -0.0336   0.0101   0.0807   0.0392   1.0000

EIGENVECTORS

 VALUE       FE        S         SI        AL        CA
  1.7229    0.5916    0.6419   -0.3463   -0.3352   -0.0754
  1.3649    0.4050    0.2862    0.6049    0.5997    0.1688
  0.9893   -0.0653    0.0426   -0.0785   -0.1726    0.9788
  0.5742   -0.0641    0.0567   -0.7007    0.7056    0.0614
  0.3487   -0.6911    0.7079    0.1304    0.0154   -0.0637

   REGRESSIONS


S  =  2.6844 +  0.9629FE + -0.2564SI
FE(CLAY) =  0.6896  FE(PYRT) =  2.0214

ORGANIC S=      2.684  MINERAL S=      1.946
```

```
308 FL FG 200 1.4SG            3205.DAT

                          CORRELATIONS

       MEAN     SIGMA     FE        S         SI        AL        CA

 FE    0.9633   0.2446    1.0000    0.1279    0.2388    0.0698   -0.1424
 S     3.0213   0.2529    0.1279    1.0000    0.0607    0.1812   -0.1285
 SI    2.0248   0.2483    0.2388    0.0607    1.0000    0.3968   -0.0501
 AL    1.8265   0.2761    0.0698    0.1812    0.3968    1.0000   -0.1326
 CA    0.5857   0.4239   -0.1424   -0.1285   -0.0501   -0.1326    1.0000

EIGENVECTORS

  VALUE       FE          S           SI          AL          CA
   1.6408     0.4068      0.3532      0.5515      0.5515     -0.3185
   1.0379     0.2161      0.4722     -0.4914     -0.3272     -0.6179
   0.9313    -0.7585      0.4817     -0.1548      0.4107      0.0085
   0.8612     0.3094      0.6146     -0.0380     -0.1782      0.7024
   0.5287    -0.3417      0.2063      0.6550     -0.6232     -0.1527

     REGRESSIONS

S  =  3.0447 +  0.1390SI + -0.5207CA

ORGANIC S=       3.021  MINERAL S=       0.000
```

```
308 FL FG 325 1.4SG                3206.DAT

                          CORRELATIONS

      MEAN      SIGMA     FE        S        SI       AL       CA

FE   1.2914    0.3117   1.0000   0.0129   0.0615   0.0448   0.1353
S    2.3650    0.2368   0.0129   1.0000   0.0684   0.0105  -0.0447
SI   2.6927    0.3172   0.0615   0.0684   1.0000   0.3922  -0.0392
AL   8.6737    0.4042   0.0448   0.0105   0.3922   1.0000  -0.1561
CA   0.4558    0.3793   0.1353  -0.0447  -0.0392  -0.1561   1.0000

EIGENVECTORS

  VALUE       FE         S         SI         AL         CA
  1.4487    0.0756    0.1462    0.6533    0.6815   -0.2859
  1.1374    0.7309   -0.0492    0.1868    0.0248    0.6541
  0.9970    0.0958    0.9768   -0.0415   -0.1865   -0.0146
  0.8335   -0.6688    0.0923    0.3303    0.0145    0.6595
  0.5834   -0.0595    0.1166   -0.6539    0.7071    0.2352

   REGRESSIONS


S  =  2.1772 +  0.2397FE + -0.2671CA
FE(CLAY) =  0.5079  FE(PYRT) =  0.7835

ORGANIC S=       2.177  MINERAL S=      0.188
```

```
308 1.6FL GRD                    3174.DAT

                          CORRELATIONS

      MEAN      SIGMA     FE        S         SI        AL        CA

FE    2.2638   0.7041   1.0000   0.7844   0.1122   0.0233  -0.0531
S     4.1046   0.6399   0.7844   1.0000   0.1840   0.1059   0.0128
SI    3.1400   0.4646   0.1122   0.1840   1.0000   0.5708  -0.0769
AL    2.1742   0.3314   0.0233   0.1059   0.5708   1.0000   0.0050
CA    0.5653   0.4313  -0.0531   0.0128  -0.0769   0.0050   1.0000

EIGENVECTORS

  VALUE       FE         S          SI         AL         CA
   1.9229    0.5837     0.6148     0.4062     0.3362    -0.0571
   1.4462   -0.4086    -0.3361     0.5696     0.6269    -0.0522
   1.0044   -0.0272     0.0661    -0.0189     0.1173     0.9903
   0.4184    0.0444     0.0420    -0.7133     0.6914    -0.0971
   0.2080   -0.6998     0.7092    -0.0383    -0.0463    -0.0618

    REGRESSIONS


S  =  1.6078 +  0.9001FE +  0.2112AL
FE(CLAY) =  0.0000  FE(PYRT) =  2.2638

ORGANIC S=       1.608  MINERAL S=       2.497
```

```
308 FL FG 100 1.6SG              3207.DAT

                            CORRELATIONS

        MEAN      SIGMA     FE        S         SI        AL        CA

FE     1.2534    0.3032    1.0000    0.3768    0.0039   -0.1160    0.0211
S      3.1966    0.3122    0.3768    1.0000   -0.0909   -0.0111    0.0853
SI     1.4769    0.2458    0.0039   -0.0909    1.0000    0.3774    0.0891
AL     4.0027    0.3403   -0.1160   -0.0111    0.3774    1.0000   -0.0536
CA     0.5271    0.4024    0.0211    0.0853    0.0891   -0.0536    1.0000

EIGENVECTORS

 VALUE        FE          S           SI          AL          CA
  1.4874    -0.5134     -0.5095      0.4657      0.5033     -0.0816
  1.2895     0.4482      0.4684      0.5457      0.4673      0.2521
  1.0037    -0.2050     -0.1319      0.0634     -0.2498      0.9350
  0.7181    -0.5231      0.5308     -0.4710      0.4580      0.1145
  0.5013     0.4689     -0.4711     -0.5094      0.5062      0.2061

    REGRESSIONS


S   =  1.8402 +  1.0450FE +  0.0316SI
FE(CLAY) =  0.0000  FE(PYRT) =  1.2534

ORGANIC S=        1.840  MINERAL S=       1.356
```

```
308 FL FG 325 1.6SG                3208.DAT

                              CORRELATIONS

        MEAN       SIGMA     FE        S         SI        AL        CA

  FE    1.1696    0.3000    1.0000    0.0926    0.0449   -0.0261   -0.1567
  S     2.4763    0.2835    0.0926    1.0000   -0.1050   -0.0884   -0.0486
  SI    2.6930    0.3715    0.0449   -0.1050    1.0000    0.5421   -0.0329
  AL    9.1750    0.4809   -0.0261   -0 0884    0.5421    1.0000   -0.2156
  CA    0.4897    0.4129   -0.1567   -0.0486   -0.0329   -0.2156    1.0000

EIGENVECTORS

  VALUE         FE          S           SI          AL          CA
   1.6197     0.0610     -0.1769      0.6483      0 6852     -0.2743
   1.2027     0.6423      0.5066     -0.1226     -0.0350     -0.5609
   0.8999    -0.3423      0.8430      0.2135      0.1711      0.3121
   0.8634     0.6658     -0.0362      0.3170     -0.1016      0.6668
   0.4143     0.1527     -0.0128     -0.6470      0.6998      0.2610

    REGRESSIONS

S  =  3.3924 +  0.7285FE + -0.1927AL
FE(CLAY) =  2.4271  FE(PYRT) = -1.2575

ORGANIC S=       2.476  MINERAL S=      0.000
```

```
330 VF 2000X                          3270.DAT

                                   CORRELATIONS

          MEAN      SIGMA      FE       S       SI       AL       CA

FE       1.3107    0.7623   1.0000   0.8718   0.0424   0.1046   0.0777
S        1.9136    0.7289   0.8718   1.0000   0.0228   0.0956   0.0559
SI       1.2200    0.2367   0.0424   0.0228   1.0000   0.5944  -0.1070
AL       0.8732    0.2480   0.1046   0.0956   0.5944   1.0000  -0.1232
CA       0.3249    0.3422   0 0777   0.0559  -0.1070  -0.1232   1.0000

EIGENVECTORS

  VALUE        FE          S          SI          AL          CA
  1.9285     0.6621     0.6579     0.2220      0.2802      0.0323
  1.5992    -0.2295    -0.2375     0.6451      0.6227     -0.2951
  0.9426    -0.0772    -0.1096     0.2135      0.1609      0.9542
  0.4021    -0.0465    -0.0223    -0.6990      0.7127      0.0299
  0.1276    -0.7077     0.7059     0.0212     -0.0041      0.0198

    REGRESSIONS


S  =  0.6951 +  0.9554FE + -0.0386AL
FE(CLAY) =  0.0354  FE(PYRT) =  1.2753

ORGANIC S=       0.695  MINERAL S=      1.218
```

```
330FL FG1.440 2K                  3263.DAT

                          CORRELATIONS

       MEAN       SIGMA     FE        S         SI        AL        CA

FE    0.2286     0.1703   1.0000  -0.1057    0.0080    0.0434    0.1057
S     0.6892     0.1707  -0.1057   1.0000   -0.1486    0.0588   -0.0484
SI    0.3163     0.2268   0.0080  -0.1486    1.0000    0.2927   -0.0196
AL    3.8828     0.2852   0.0434   0.0588    0.2927    1.0000   -0.1892
CA    0.2823     0.3128   0.1057  -0.0484   -0.0196   -0.1892    1.0000

EIGENVECTORS

  VALUE        FE          S          SI          AL          CA
   1.3602    -0.0141    0.0963    -0.6168    -0.6846     0.3761
   1.2086    -0.5470    0.6180    -0.2858     0.0930    -0.4781
   0.9469     0.7296    0.5607    -0.2230     0.3108     0.0837
   0.8817    -0.3419    0.4263     0.3906     0.1169     0.7315
   0.6026     0.2266    0.3358     0.5793    -0.6422    -0.2965

     REGRESSIONS

S   = -1.9523 +  0.8365AL + -1.2851SI

ORGANIC S=       0.000  MINERAL S=       0.889
```

```
330 1.4FL GRD                    3173.DAT

                             CORRELATIONS
      MEAN      SIGMA     FE        S         SI        AL        CA

FE    1.2907    0.9400    1.0000    0.8431    0.1203   -0.0109    0.1534
S     1.8081    0.8069    0.8431    1.0000    0.1031   -0.0056    0.0045
SI    1.2273    0.2572    0.1203    0.1031    1.0000    0.5280    0.0681
AL    0.7294    0.2196   -0.0109   -0.0056    0.5280    1.0000    0.0519
CA    0.3808    0.3898    0.1534    0.0045    0.0681    0.0519    1.0000

EIGENVECTORS

 VALUE       FE          S           SI          AL          CA
  1.9029     0.6730      0.6584      0.2639      0.1505      0.1462
  1.5030    -0.2087     -0.2245      0.6450      0.6938      0.0933
  0.9889     0.0080     -0.1654     -0.0957     -0.0935      0.9771
  0.4619     0.0376      0.0843     -0.7104      0.6976      0.0112
  0.1435    -0.7066      0.6940      0.0219     -0.0254      0.1231

  REGRESSIONS


S  =  0.7911 +  0.8450FE + -0.1010AL
FE(CLAY) =  0.0872  FE(PYRT) =  1.2035

ORGANIC S=       0.791  MINERAL S=      1.017
```

```
330FL FG1.4 100 2K              3264.DAT

                              CORRELATIONS

       MEAN      SIGMA     FE       S        SI       AL       CA

FE    0.4099    0.3990   1.0000   0.7610   0.0926   0.0762  -0.0413
S     1.0094    0.3144   0.7610   1.0000  -0.0023   0.2125   0.0252
SI    0.4681    0.2614   0.0926  -0.0023   1.0000   0.3483   0.1662
AL    3.7904    0.3375   0.0762   0.2125   0.3483   1.0000  -0.0497
CA    0.3291    0.3005  -0.0413   0.0252   0.1662  -0.0497   1.0000

EIGENVECTORS

 VALUE         FE          S          SI          AL          CA
  1.8422     0.6503     0.6651     0.1990     0.3084     0.0091
  1.3062    -0.2482    -0.2230     0.7082     0.5383     0.3121
  1.0258     0.0986     0.0943     0.0140    -0.4465     0.8842
  0.6268    -0.2644     0.1655    -0.6495     0.6099     0.3300
  0.1989    -0.6602     0.6867     0.1919    -0.2095    -0.1085

    REGRESSIONS

S  =  0.6608 +  0.7964FE +  0.0474SI
FE(CLAY) =  0.0000  FE(PYRT) =  0.4099

ORGANIC S=       0.661  MINERAL S=       0.349
```

```
330FL FG1.4 20A 2K              3265.DAT

                          CORRELATIONS

      MEAN       SIGMA     FE        S        SI        AL        CA

FE   0.5056    0.3204   1.0000   0.4967  -0.0630   0.1376  -0.0382
S    1.0736    0.2665   0.4967   1.0000  -0.1264   0.0950   0.0453
SI   0.4733    0.2462  -0.0630  -0.1264   1.0000   0.3655   0.1057
AL   5.8490    0.3631   0.1376   0.0950   0.3655   1.0000  -0.1316
CA   0.3124    0.3408  -0.0382   0.0453   0.1057  -0.1316   1.0000

EIGENVECTORS

  VALUE        FE          S          SI          AL          CA
  1.5504     0.6858     0.6750    -0.0797      0.2512     -0.0674
  1.3672    -0.0412    -0.1322     0.7167      0.6817     -0.0500
  1.0592     0.0312     0.1557     0.2579     -0.1702      0.9377
  0.5443    -0.4800     0.2220    -0.5453      0.6049      0.2389
  0.4790    -0.5446     0.6733     0.3408     -0.2781     -0.2378

   REGRESSIONS


S  =  1.2043 +  0.8588FE + -0.0966AL
FE(CLAY) =  0.6578  FE(PYRT) = -0.1522

ORGANIC S=      1.074  MINERAL S=      0.000
```

```
330FL FG1.4 325 2K                 3268.DAT

                           CORRELATIONS

      MEAN      SIGMA    FE       S        SI       AL       CA

FE   0.4498    0.2110   1.0000   0.1419   0.0283  -0.0165   0.0934
S    1.0011    0.2100   0.1419   1.0000   0.0945   0.0160   0.0151
SI   1.0522    0.3026   0.0283   0.0945   1.0000   0.2934   0.1967
AL   4.8589    0.4236  -0.0165   0.0160   0.2934   1.0000   0.1498
CA   0.2905    0.3211   0.0934   0.0151   0.1987   0.1498   1.0000

EIGENVECTORS

VALUE        FE         S          SI         AL         CA
 1.4617     0.1835     0.2174     0.6153     0.5502     0.4876
 1.1290     0.6962     0.6262    -0.1345    -0.3240    -0.0059
 0.9274    -0.4039     0.5995     0.2090     0.2156    -0.6223
 0.7930    -0.5615     0.3950    -0.0409    -0.4369     0.5798
 0.6889    -0.0565     0.2125    -0.7470     0.5958     0.1969

   REGRESSIONS

S  =  0.3831 +  0.9333FE +  0.0408AL
FE(CLAY) =  0.0000  FE(PYRT) =  0.4498

ORGANIC S=       0.383  MINERAL S=      0.618
```

```
330FL FG1.6 40 2K              3266.DAT

                          CORRELATIONS

      MEAN      SIGMA     FE       S        SI       AL       CA

FE   0.2486   0.2130   1.0000   0.0427   0.1496   0.1067   0.0058
S    0.9505   0.1952   0.0427   1.0000  -0.0646   0.1733   0.0356
SI   0.4075   0.2792   0.1496  -0.0646   1.0000   0.3789   0.0557
AL   4.2645   0.3756   0.1067   0.1733   0.3789   1.0000   0.1460
CA   0.3332   0.3246   0.0058   0.0356   0.0557   0.1460   1.0000

EIGENVECTORS

  VALUE        FE          S          SI          AL          CA
   1.5079    0.3313     0.1952     0.5913     0.6552     0.2707
   1.0603   -0.2308     0.8038    -0.4156     0.1121     0.3395
   0.9917   -0.5781    -0.4204     0.0874     0.0530     0.6918
   0.8929   -0.7042     0.1325     0.2685     0.3079    -0.5654
   0.5472    0.0828    -0.3485    -0.6308     0.6787    -0.1149

    REGRESSIONS

S  = -2.2669 + -1.0423SI +  0.8541AL

ORGANIC S=      0.000  MINERAL S=      0.951
```

```
330 1.6FL GRD                     3175.DAT

                               CORRELATIONS

       MEAN      SIGMA     FE        S         SI        AL        CA

FE    1.4007    0.5703    1.0000    0.8431    0.0104    0.0472   -0.0964
S     1.9307    0.5418    0.8431    1.0000   -0.0128    0.0069   -0.1264
SI    1.3753    0.2581    0.0104   -0.0128    1.0000    0.6402   -0.0744
AL    0.8530    0.2489    0.0472    0.0069    0.6402    1.0000   -0.1134
CA    0.3658    0.3389   -0.0964   -0.1264   -0.0744   -0.1134    1.0000

EIGENVECTORS

 VALUE       FE          S          SI          AL          CA
  1.8830     0.6767     0.6745     0.1355     0.1658     -0.2031
  1.6531    -0.1580    -0.1849     0.6806     0.6774     -0.1359
  0.9501     0.1411     0.0949     0.1523     0.1003      0.9684
  0.3587     0.0225    -0.0437    -0.7035     0.7079      0.0383
  0.1551    -0.7046     0.7071    -0.0152     0.0492      0.0307

    REGRESSIONS


S  =  0.6611 +  0.9556FE + -0.0808AL
FE(CLAY) =  0.0721  FE(PYRT) =  1.3286

ORGANIC S=      0.661  MINERAL S=      1.270
```

```
330FL FG1.6 100 2K                    3269.DAT

                                   CORRELATIONS
         MEAN       SIGMA     FE        S         SI        AL        CA
FE     0.4580     0.2678   1.0000    0.3728    0.1787    0.0937   -0.1489
S      0.9866     0.2497   0.3728    1.0000   -0.0241    0.1813   -0.1440
SI     0.1047     0.1953   0.1787   -0.0241    1.0000    0.2680    0.0895
AL     8 6031     0.4703   0.0937    0.1813    0.2680    1.0000    0.0758
CA     0.3581     0.3683  -0.1489   -0 1440    0.0895    0.0758    1.0000

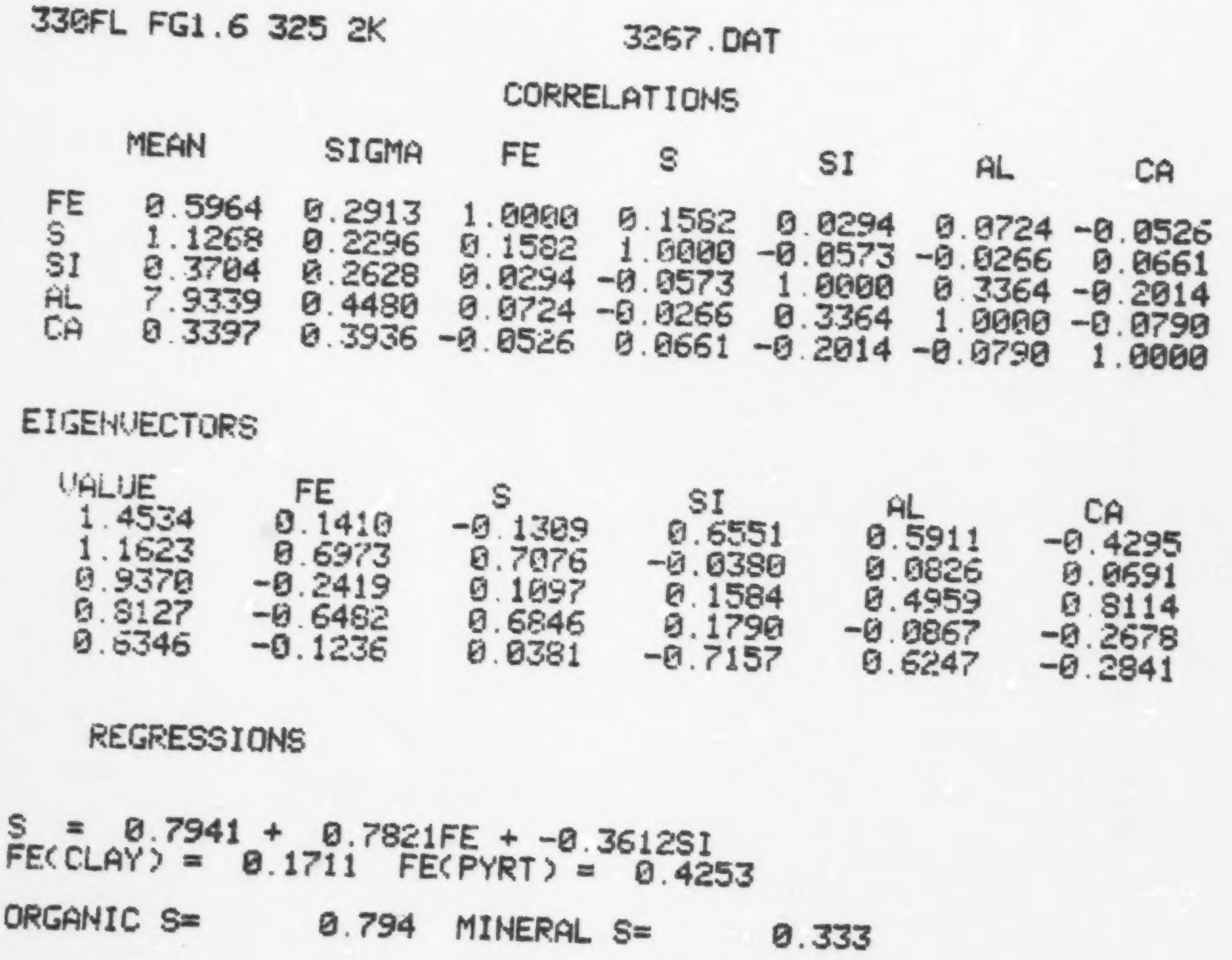
EIGENVECTORS

  VALUE        FE          S          SI          AL          CA
  1 5633     0.6002     0.5660     0.3320     0.4137     -0.1949
  1.2689    -0.1795    -0.2908     0.5704     0.4728      0.5782
  0.8551    -0.1480     0.4937    -0.5889     0.2750      0.5584
  0.7912    -0.5160    -0.0305    -0.1329     0.6324     -0.5615
  0 5215    -0.5652     0.5919     0.4471    -0.3602     -0.0243

   REGRESSIONS

S  =  0.5653 +  0.9728FE + -0.2320SI
FE(CLAY) =  0.0250  FE(PYRT) =  0.4330

ORGANIC S=      0.565  MINERAL S=      0.421
```



```
330FL FG1.6 325 2K              3267.DAT

                          CORRELATIONS
      MEAN      SIGMA     FE       S        SI       AL       CA

FE   0.5964   0.2913   1.0000   0.1582   0.0294   0.0724  -0.0526
S    1.1268   0.2296   0.1582   1.0000  -0.0573  -0.0266   0.0661
SI   0.3704   0.2628   0.0294  -0.0573   1.0000   0.3364  -0.2014
AL   7.9339   0.4480   0.0724  -0.0266   0.3364   1.0000  -0.0790
CA   0.3397   0.3936  -0.0526   0.0661  -0.2014  -0.0790   1.0000

EIGENVECTORS

 VALUE        FE         S          SI          AL          CA
  1.4534    0.1410    -0.1309     0.6551      0.5911     -0.4295
  1.1623    0.6973     0.7076    -0.0380      0.0826      0.0691
  0.9370   -0.2419     0.1097     0.1584      0.4959      0.8114
  0.8127   -0.6482     0.6846     0.1790     -0.0867     -0.2678
  0.6346   -0.1236     0.0381    -0.7157      0.6247     -0.2841

  REGRESSIONS


S  =  0.7941 +  0.7821FE + -0.3612SI
FE(CLAY) =  0.1711   FE(PYRT) =  0.4253

ORGANIC S=      0.794  MINERAL S=      0.333
```

APPENDIX C

RAW DATA FOR PSOC 308 AND PSOC 330 COALS

```
330 PASS 40 AREA 1
     H   AMPS      V   TIME      FE       S      SI      AL      CA

                           PYRITE
     6    360      4    300    9953    9712       0       0       0
     2    361     15    300    9278   10387       0       0     224
     5    362      8    300    9843    9389     109     194       0
     1    361      2    300    9794    9990       0      58      59
     6    360      8    300    9659   10068       0       0       0
     3    360      8    300    9957   10120       0      75      71
     4    361      5    300   10253   10412       0      10       0
     1    361     12    300    9632    9843      33     189     107
     6    361      3    300    9258    9579      51     327     148
                           DATA
     4   1093    355    300     411     697     292     163     158
     2   1130    334    300     526    1052     821     604       0
     3   1114     63    300     534     464   10046   10457     276
     1   1121    286    300     490     720    1332    1264     105
     2   1128    364    300     170     605     182     178     163
     3   1133    417    300     137     557     379     342     123
     5   1138    367    300     666    1065     411     239      70
     5   1109    450    300     278     883     167      42       6
     5   1135    373    300     609    1123     801     538     243
     2   1142    323    300     544     865     449     204     149
     4   1121    323    300     176     458     263     183       0
     5   1098    362    300     690    1042     658     560      59
     1   1090    354    300    2007    2177     483     293     156
     7   1153    368    300     272     511     263     240       0
     3   1079    392    300     657     835     357     239      73
     1   1086    340    300     720     828     709     560     347
     1   1139    388    300     562     714     241     103     403
     4   1123    351    300     536     843     441     326       0
     4   1142    316    300     469     729     819     628     244
     2   1056    265    300    2236    1650     376     344       0
     2   1107    394    300     368     613     759     565     334
     6   1064    226    300    2813    2647    3761    3895       0
     0   1148    358    300     912    1101     223     191     189
     2   1099    282    300     999    1179     569     488     197
     6   1077    327    300     900    1047     827     434     180
     3   1116    315    300     667     702     818     375     164
     2   1114    365    300     778     934     539     534     378
     4   1124    341    300     467     810     393     225       0
     2   1137    338    300    1087    1731     520     317     284
     4   1159    407    300     118     491     299     212       0
     2   1081    321    300     601     857     460     356       0
     5   1130    332    300    2526    2471     727     575       0
     6   1076    273    300    1943    2219      53       0     119
     6   1091    299    300    1940    2117     704     404       0
     2   1116    371    300     539     695     892     525     287
     0   1133    389    300     438     841     285     225     303
     2   1106    379    300     474     807     445     345      66
     3   1154    320    300     362     634     344     216       0
     9   1133    354    300     175     394     157       0     163
     0   1133    319    300     985    1268     432     292     151
```

H	AMPS	V	TIME	FE	S	SI	AL	CA
7	1088	273	300	1543	1298	2097	1256	223
2	1135	397	300	330	737	363	282	77
1	1118	374	300	422	682	358	222	88
5	1151	444	300	271	313	234	148	220
3	1096	196	300	1994	1747	4868	3026	48
3	1098	324	300	455	653	347	112	0
5	1134	320	300	634	744	113	9	399
3	1090	330	300	447	725	295	79	291
3	1091	309	300	1432	1376	746	786	0
3	1125	443	300	186	490	257	153	0
2	1127	318	300	435	714	795	573	0
3	1150	345	300	207	530	377	272	0
5	1131	304	300	405	903	413	352	94
1	1157	338	300	488	1011	450	239	0
6	1112	310	300	866	1071	300	253	134
2	1138	302	300	329	809	496	264	0
5	1127	341	300	345	819	172	118	0
9	1091	241	300	6464	5511	337	141	232
5	1121	305	300	1598	2105	1027	754	49
1	1148	311	300	1098	1159	1393	946	288
3	1[illegible]58	351	300	737	934	447	287	100
4	1133	326	300	536	954	577	413	0
6	1090	323	300	530	815	426	401	52
2	1137	301	300	1241	1526	770	614	124
3	1134	304	300	451	892	437	255	20
5	1105	370	300	499	837	327	233	0
2	1108	265	300	1175	1409	453	259	43
2	1095	298	300	758	1185	929	572	114
3	1142	354	300	309	489	411	305	0
5	1122	337	300	435	570	280	137	0
6	1123	343	300	837	1096	1212	637	0
3	1130	395	300	375	490	315	111	170
2	1136	370	300	606	867	492	425	0
4	1142	374	300	204	1011	713	461	0
7	1152	343	300	882	1333	849	543	196
2	1129	311	300	1493	1542	911	573	182
3	1096	327	300	1449	1557	539	374	0
5	1109	312	300	1464	1947	554	374	125
4	1122	340	300	876	1231	384	223	77
4	1152	326	300	837	1106	338	309	0
5	1137	347	300	403	773	728	358	18
2	1122	328	300	665	1193	563	335	39
5	1143	326	300	202	792	500	207	0
2	1151	306	300	497	707	290	118	0
4	1091	288	300	2687	2735	846	306	68
2	1128	304	300	560	807	320	198	217
2	1094	322	300	812	777	175	193	0
3	1138	283	300	309	510	313	212	348
6	1128	339	300	1185	1278	451	325	0
1	1126	358	300	934	1474	268	93	263
2	1130	328	300	852	1443	374	207	0

1	1147	361	300	769	1103	687	475	242
5	1122	292	300	1132	1775	610	356	88
3	1120	319	300	2788	3375	534	209	45
1	1145	341	300	790	1064	490	362	0
3	1091	267	300	2937	2937	794	622	250
25	1136	343	300	890	1223	812	583	201
7	1073	243	300	3738	3734	527	269	0
3	1092	333	300	640	1209	565	276	0
4	1114	382	300	299	970	368	168	33
6	1120	330	300	1219	1560	532	307	33
3	1138	420	300	183	578	250	217	47
3	1131	314	300	770	1222	444	330	193
1	1116	290	300	701	935	855	702	368
2	1140	285	300	996	1145	781	469	79
5	1126	293	300	537	1308	1258	854	30
1	1109	363	300	1523	1893	468	210	240
1	1109	330	300	369	651	349	247	108
2	1125	351	300	358	510	850	273	6
4	1145	313	300	645	1145	1006	559	133
1	1111	296	300	1000	1447	218	162	102
5	1086	235	300	640	887	3154	1707	0
3	1147	412	300	313	568	325	310	92
5	1137	324	300	530	633	389	167	15
1	1122	372	300	321	578	242	89	29
3	1111	373	300	479	731	326	168	194
4	1087	239	300	4528	4256	1183	780	82
5	1132	456	300	492	913	220	177	0
4	1143	399	300	687	1045	516	263	0
5	1135	298	300	652	979	924	464	157
2	1139	281	300	796	1166	362	260	80

```
330 PASS 40 AREA 2
     H   AMPS        V     TIME      FE        S       SI       AL       CA

                                  PYRITE
     6    365        3      300   10130    10291       94       56       33
     4    366        7      300    9615    10107        0       37        0
     1    368       17      300    9767     9547       15      391        0
     2    366        2      300   10348    10467        0       12       24
     5    366       10      300   10015    10319      145        0        0
     4    368        6      300    9656     9684        0      217        0
     2    366        7      300    9412    10117        8       70      311
     5    366       15      300    9684    10047      123      195        0
     5    367        6      300    9615     9921        0      394        0
                                  DATA
     2   1094      356      300     720     1166     1074      723       98
     1   1118      396      300     286      530      223      115       18
     1   1092      394      300     566      810      392      333        0
     4   1086      380      300     930     1328      235      188       47
     1   1121      359      300     554     1240      328      142      162
     4   1106      335      300     430      744      352      160        0
     1   1101      373      300     256      690      224      214       18
     4   1090      340      300    2543     3020      501      413        0
     3   1125      346      300    1013     1472     1125      618      105
     4   1084      277      300     415      806     2163     1241        0
     3   1108      245      300     869     1317     2131     1456      274
     2   1127      295      300     800     1005      628      313      354
     2   1117      340      300     159      661      396      221      108
     5   1143      368      300     213      495     1490      291      147
     8   1123      343      300    1678     2101      521      286      173
     6   1132      350      300     786      966      447      346        0
     2   1059      337      300     257      636      469      154       74
     2   1103      269      300    1979     2044      487      474      424
     2   1119      342      300     647      938      607      486       47
    14   1101      345      300     208      707      265      180      100
     4   1136      336      300     426      811      189       30      151
     1   1092      323      300    1106     1475      192      160       21
     2   1137      411      300     267      432      192      189        0
     5   1099      245      300    5356     4737     1545      956      106
    32   1137      316      300     368      603     1827     1617      418
     6   1126      391      300     353      660      391      259      210
     4   1105      317      300     903      918     1246      943        0
     1   1139      392      300     555      648      292       60      232
     7   1040      220      300    4202     4566      324      248        0
     4   1062      268      300    4684     4469      402      318      338
     3   1125      277      300    1279     1730      407      227       19
     3   1128      320      300    2484     3008      452      235      343
     2   1126      291      300     382      922     1076      946       54
     2   1135      317      300     619      887      567      411        0
     2   1085      392      300     491      473      412      317      167
     4   1057      322      300    1288     1614      623      501      122
     1   1065      279      300    3066     2391      613      296       34
     1   1106      418      300     527      859      109        0       68
     4   1051      185      300    3583     2717     1493     1327      144
     1   1099      374      300     549      747      316      215      192
```

H	AMPS	V	TIME	FE	S	SI	AL	CA
7	1116	375	300	341	836	264	185	70
4	1121	359	300	424	713	228	252	198
4	1103	381	300	275	717	530	398	123
5	1144	261	300	386	703	2470	1577	208
1	1116	313	300	1875	2348	1580	1337	120
2	1112	378	300	600	870	637	484	69
5	1095	347	300	549	1054	476	350	214
3	1121	350	300	480	1010	341	267	60
3	1121	349	300	295	507	750	668	127
7	1101	346	300	851	1276	759	353	188
3	1093	344	300	731	997	642	347	214
3	1119	410	300	346	741	342	267	0
1	1130	384	300	282	581	336	172	261
2	1043	256	300	974	1152	1875	1700	0
1	1101	444	300	272	416	125	74	2
3	1117	435	300	440	712	371	223	49
1	1132	487	300	139	340	197	66	288
5	1098	351	300	228	474	230	100	2
5	1102	291	300	896	1133	538	362	278
3	1115	324	300	550	964	483	403	56
5	1119	281	300	450	679	333	130	55
2	1123	296	300	1071	1406	746	622	8
7	1110	328	300	501	1017	324	84	0
2	1128	393	300	330	610	468	332	0
0	1125	354	300	687	910	343	145	0
3	1116	409	300	470	897	341	157	248
1	1119	361	300	830	948	541	333	399
5	1111	437	300	462	596	448	281	133
6	1072	276	300	2487	2649	416	272	106
4	1057	198	300	6462	4732	785	698	118
7	1103	330	300	977	1097	1884	485	0
1	1118	311	300	538	884	338	262	0
2	1103	355	300	875	1344	594	468	417
3	1093	315	300	438	966	2197	1878	133
1	1098	273	300	1256	1571	1827	1524	0
1	1122	359	300	268	544	289	334	0
4	1145	413	300	256	511	176	126	0
6	1136	454	300	347	492	97	143	26
8	1130	426	300	1086	1106	259	233	54
1	1131	390	300	151	311	154	160	138
3	1123	358	300	764	856	602	393	202
4	1118	244	300	646	1548	666	592	309
2	1123	371	300	384	681	385	261	0
3	1126	335	300	598	1230	491	345	0
3	1107	362	300	1886	1925	393	342	386
1	1087	355	300	2605	2561	301	166	0
2	1135	425	300	299	352	283	167	91
7	1081	246	300	2975	3284	770	582	161
5	1071	230	300	3370	3660	337	186	0
3	1106	381	300	350	601	386	202	0
2	1111	311	300	557	804	261	30	218

9	1106	372	300	138	551	276	255	171
3	1081	373	300	508	809	167	92	8
2	1129	363	300	1088	1649	249	226	210
3	1112	315	300	579	1147	653	539	6
4	1088	318	300	1440	1518	582	455	92
2	1118	319	300	830	1204	740	553	565
3	1111	327	300	509	968	247	155	107
3	1116	380	300	165	410	230	134	23
9	1121	369	300	753	1103	475	328	65
2	1113	311	300	1366	1791	539	409	339
3	1141	383	300	432	595	403	101	0
0	1121	310	300	1771	2106	515	476	93
5	1116	324	300	1117	1371	783	461	189
5	1071	423	300	142	294	100	108	0
2	1112	283	300	949	1200	1264	577	0
7	1035	186	300	8477	8479	588	305	1003
1	1111	335	300	543	1070	368	290	0
6	1128	361	300	193	703	127	114	0
5	1108	251	300	904	1048	363	214	357
2	1108	485	300	399	543	236	157	170
2	1118	376	300	977	1071	202	214	290
3	1053	307	300	2150	1422	1689	1254	0
3	1107	384	300	1584	1579	186	60	178
2	1100	361	300	488	893	261	139	436
1	1123	332	300	593	1143	690	336	408
2	1114	262	300	692	1427	389	417	239
2	1155	394	300	412	535	148	53	187
4	1107	365	300	2749	2827	526	354	182
4	1093	334	300	197	590	587	367	148
1	1098	376	300	1227	1368	930	679	0

```
330 PASS 40 AREA 3
    H   AMPS      V     TIME      FE       S      SI      AL      CA

                                PYRITE
    6    365      3      300   10130   10291      94      56      33
    4    366      7      300    9615   10107       0      37       0
    1    368     17      300    9767    9547      15     391       0
    2    366      2      300   10348   10467       0      12      24
    5    366     10      300   10015   10319     145       0       0
    4    368      6      300    9656    9684       0     217       0
    2    366      7      300    9412   10117       8      70     311
    5    366     15      300    9684   10047     123     195       0
    5    367      6      300    9615    9921       0     394       0
                                 DATA
    3   1161    280      300     931    1391     540     278     322
    5   1147    265      300    1083    1392    1332     993     140
    4   1183    385      300     256     521     357     198     196
    3   1175    394      300     248     565       0      19     173
    0   1170    334      300     427     802     406     226     147
    3   1174    440      300     248     609     259     111       0
    1   1151    332      300    3203    2924     849     527      48
    4   1170    394      300    1258    1324     410     217     195
    2   1158    330      300     713     925     954     570     660
    0   1179    330      300     529     952     553     338      34
    0   1188    321      300     470    1144     486     347     104
    3   1166    382      300     638    1193     390     253     231
    4   1146    224      300     828    1164    3329    2929     361
    2   1163    290      300    2365    2663     575     558       0
    3   1142    336      300    1434    1868     427     237       0
   21   1152    399      300    1539    1650     536     268       0
    5   1158    353      300     904    1382     543     278     347
    8   1123    325      300    4514    4600     683     355      11
    5   1163    375      300     847    1180     606     345     329
    4   1149    366      300     635    1070     576     405     300
    2   1142    327      300     826     757     359     308     374
    4   1100    400      300     440     831     230     115       0
    7   1132    312      300    1003    1388     813     555    1598
    4   1108    380      300     708    1109    1032     849       0
    4   1114    336      300     516    1162     458     298     108
    2   1108    428      300     380     710     747     301     284
    2   1132    319      300     734     823     451     350     253
    2   1149    290      300     751    1610     819     511     252
    5   1082    176      300    7444    7500    1367     985     673
    1   1121    314      300     990    1667     564     364     134
    3   1115    389      300     477     651    1238     628       0
    9   1149    398      300     258     421     272     114     121
    5   1132    279      300    3422    4051     846     466       8
    4   1127    324      300     670    1161     728     520      44
    2   1138    308      300     693     979    1005     566     124
    2   1150    363      300     625    1061     417     190     317
    6   1140    323      300     589     865     695     385     309
    6   1159    312      300     548     661     791     538      65
    3   1139    360      300     514     876     385     223      60
    8   1107    293      300    1863    1844    1720    1267     489
```

H	AMPS	V	TIME	FE	S	SI	AL	CA
3	1134	325	300	485	1065	266	183	0
1	1119	350	300	610	777	300	155	94
4	1134	340	300	895	1189	377	296	0
4	1127	403	300	493	709	254	99	159
7	1098	286	300	755	1136	822	604	191
5	1132	330	300	452	763	769	523	97
4	1131	309	300	780	975	486	264	0
1	1150	392	300	206	584	132	110	138
3	1128	316	300	419	780	424	269	40
2	1131	364	300	661	875	380	175	16
3	1145	352	300	376	438	265	147	185
4	1085	389	300	774	930	376	89	142
3	1095	390	300	993	1054	307	134	0
1	1124	329	300	1212	1565	785	623	164
2	1155	363	300	988	1311	475	337	266
3	1143	353	300	1054	1209	620	369	64
1	1086	220	300	4515	4022	1049	799	0
3	1121	264	300	2204	2431	152	128	0
3	1111	384	300	1450	1635	422	324	14
3	1114	360	300	857	1171	205	167	17
3	1126	325	300	288	603	351	235	191
2	1124	305	300	1104	1246	765	462	0
5	1107	307	300	676	1046	238	122	162
4	1121	305	300	228	698	310	234	38
1	1099	300	300	705	786	39	59	0
2	1158	337	300	351	450	208	132	70
6	1132	300	300	191	580	1400	649	279
5	1156	347	300	758	1055	582	263	155
1	1118	268	300	878	1247	1260	769	145
3	1109	278	300	870	1192	376	283	118
0	1130	340	300	908	1104	403	284	0
2	1089	389	300	533	712	177	126	218
0	1109	328	300	295	736	434	263	0
8	1126	235	300	526	768	508	301	332
1	1098	256	300	494	857	419	293	52
1	1104	273	300	531	1060	889	367	514
3	1078	338	300	1077	1222	248	119	287
2	1139	376	300	430	985	273	115	129
5	1122	320	300	1224	1703	413	303	51
4	1102	335	300	891	1040	584	467	230
2	1123	398	300	943	1341	273	159	147
12	1148	358	300	441	797	239	163	282
5	1097	306	300	749	1151	480	357	22
2	1130	366	300	587	815	366	187	283
1	1124	369	300	570	750	191	174	183
3	1139	324	300	1226	1559	729	562	94
4	1121	351	300	339	604	418	158	0
4	1111	340	300	575	851	236	82	290
2	1098	299	300	684	883	987	532	163
2	1146	312	300	1825	2446	764	458	14
8	1080	312	300	1107	1362	927	689	65

7	1143	421	300	677	1262	337	246	0
3	1136	265	300	2061	2236	575	462	92
9	1115	244	300	1444	1884	1861	1586	142
6	1137	385	300	1056	1481	333	244	341
3	1095	398	300	631	900	359	136	49
1	1152	419	300	226	437	233	75	235
2	1120	362	300	396	971	312	195	0
1	1110	297	300	2714	3102	666	589	184
4	1138	358	300	411	534	254	98	151
8	1138	354	300	2331	2408	458	302	345
1	1106	301	300	2860	2959	452	327	20
6	1078	317	300	701	934	405	279	139
8	1142	281	300	248	549	882	689	59
7	1117	359	300	1436	1937	417	349	73
2	1147	367	300	431	876	618	423	123
6	1147	397	300	571	689	261	134	0
2	1113	300	300	1131	1403	474	308	172
4	1137	375	300	476	817	302	203	143
0	1107	435	300	259	658	90	0	26
3	1116	287	300	1841	1763	1326	646	148
3	1096	352	300	293	535	186	70	0
4	1136	380	300	633	864	178	50	83
2	1110	324	300	147	436	287	236	189
2	1127	342	300	1147	1520	321	135	307
0	1109	347	300	600	995	319	217	157
3	1117	336	300	391	657	587	361	203
4	1141	390	300	843	941	434	293	170
6	1136	355	300	750	883	479	481	228
4	1129	305	300	674	959	1602	923	320
3	1147	318	300	589	1005	476	246	0

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330 PASS 40 AREA 4
   H   AMPS      V    TIME      FE       S      SI      AL      CA

                           PYRITE
   4    360      4     300   10204   10419       0      72     145
   9    360      8     300    9458   10333      38       0       0
   7    362     11     300    9361    9209       0     147      14
   4    361      8     300    9703    9977       0       0      79
   4    361      3     300    9983   10477       0       0       0
   6    362      6     300    9528   10100      13      24       0
   7    361      6     300    9916    9928       0       0     216
   2    360     10     300   10142   10311      27     110       0
   4    362      9     300    9339    9744       0     271       0
                           DATA
   7   1053    267     300    7275    6843     850     628     457
   7   1113    323     300    1240    1317     401     385       5
   3   1141    398     300     348     682     316     272      15
   2   1115    333     300    4052    4303     389     234     162
   2   1146    337     300     623    1027     252     194       4
   7   1112    392     300     364     907     439     257      76
   7   1142    415     300     253     695     352     206     158
   5   1164    403     300     453     729     413     418     320
   5   1180    346     300     632     930     357     190     211
   4   1130    299     300    1279    1684     673     438     178
   3   1180    317     300     402     769     379     187     228
   2   1159    396     300     466     942     359     207      59
   1   1118    277     300     684     957     979     630     398
   2   1113    304     300     607     859     347     167     111
   4   1134    377     300     951    1352     284      99     133
   5   1105    381     300     604     885     279     236     123
   5   1110    539     300     220     504      65      58      72
   4   1155    521     300     201     329     221     117      34
   6   1108    288     300    1624    2028    3091    2215     191
   2   1162    315     300     848    1068    1970    1444     136
   1   1155    352     300     715    1258     414     163       0
   3   1161    378     300     602    1079     264     214     221
   4   1141    420     300     331     713     277     190     308
   9   1140    332     300    2733    3052     313     285       0
   5   1134    392     300    2809    2857     445     240      15
   2   1150    179     300     665     663    8467    6517       7
   5   1151    156     300     692     741    9072    7568      17
   6   1093    235     300     753     796    4742    3741     187
   2   1092    383     300     993    1157     946     345       0
   2   1105    198     300    1800    1230    5411    2975     536
   0   1122    373     300     680    1063     402     232       0
   5   1078    288     300    4500    5439     226      94       0
   2   1129    334     300     768    1070     638     519      18
   5   1121    303     300    1404    1640     692     333       0
   2   1129    347     300    1270    1623     427     409     276
   3   1153    417     300     907    1264     368     339     168
   6   1147    372     300     408    1078    1096     346       0
   5   1126    321     300    1362    1675    1181     942     244
   1   1148    374     300     875    1366     879     247     144
   3   1164    422     300     889    1265     310     248      57
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H	AMPS	V	TIME	FE	S	SI	AL	CA
2	1141	317	300	890	1160	826	647	181
4	1109	78	300	746	523	9876	8425	93
2	1121	172	300	610	514	9380	7345	207
6	1100	275	300	5864	5507	601	397	325
3	1085	272	300	4117	4036	1458	1089	293
5	1089	305	300	1413	1527	1047	729	0
4	1151	299	300	1864	2209	670	570	0
3	1107	400	300	1391	1459	764	479	0
4	1141	319	300	515	1069	863	657	615
3	1116	321	300	914	1046	474	301	15
2	1111	292	300	716	1249	498	251	32
2	1102	360	300	624	885	475	257	0
2	1110	337	300	522	1039	645	442	307
3	1122	321	300	751	1034	619	544	286
7	1155	441	300	290	558	225	129	175
0	1134	476	300	555	684	284	117	232
4	1132	406	300	1227	1194	479	337	167
6	1115	361	300	822	1192	446	358	0
4	1149	395	300	274	794	197	175	0
4	1134	382	300	287	733	485	347	0
2	1118	357	300	2938	3037	641	375	66
2	1074	329	300	718	1144	287	211	67
3	1153	444	300	226	518	505	300	85
3	1127	481	300	324	698	386	239	35
1	1118	332	300	480	815	389	232	0
2	1118	376	300	611	926	419	249	116
3	1122	281	300	878	1683	1108	914	109
6	1093	295	300	764	1127	773	491	37
1	1104	420	300	561	798	402	232	80
4	1105	452	300	629	799	258	115	365
2	1072	302	300	725	1188	783	607	0
4	1133	413	300	315	828	208	150	95
4	1120	361	300	1261	1598	734	303	53
4	1141	416	300	477	584	455	258	0
2	1179	407	300	252	392	287	145	212
7	1114	324	300	295	1078	1345	1113	0
4	1111	358	300	330	735	1614	962	0
3	1133	464	300	607	778	871	421	812
2	1099	349	300	521	838	379	325	0
4	1155	351	300	367	693	753	522	35
5	1092	294	300	786	958	883	649	141
2	1142	383	300	938	1006	488	257	112
1	1170	422	300	133	374	470	237	0
4	1153	395	300	472	673	683	443	0
2	1077	378	300	704	1035	164	59	0
2	1117	322	300	528	876	576	337	0
3	1126	358	300	362	919	252	34	120
6	1129	263	300	2087	2628	572	512	0
6	1102	356	300	420	698	257	223	0
6	1030	156	300	11726	9805	256	218	42
7	1051	220	300	9339	7178	349	244	187

6	1070	256	300	3299	3163	1096	678	34
3	1097	341	300	2414	2836	362	270	418
5	1120	376	300	953	1211	623	406	408
5	1151	307	300	380	530	1757	605	292
3	1156	343	300	782	1007	821	524	77
3	1157	358	300	262	500	625	318	0
2	1109	270	300	1959	2184	567	282	102
1	1106	229	300	950	1422	666	426	19
4	1136	304	300	472	739	986	516	156
3	1140	354	300	661	955	938	524	249
7	1074	218	300	7617	6600	401	261	87
2	1105	274	300	5085	5184	842	604	0
7	1128	220	300	1428	1811	2742	1840	269
5	1110	331	300	390	870	638	312	195
25	1114	386	300	685	783	404	302	181
2	1133	377	300	664	804	316	319	358
3	1113	384	300	1389	1536	627	361	319
3	1136	369	300	544	1141	419	309	0
8	1035	131	300	5980	5510	3456	3026	278
11	916	47	300	21552	18204	115	25	565
2	1111	311	300	3867	4177	385	222	186
6	1162	340	300	461	681	489	332	282
2	1157	345	300	619	952	1342	1043	133
0	1127	297	300	1794	1923	651	543	0
4	1121	336	300	311	373	207	141	6
2	1040	470	300	390	650	439	264	0
1	1115	352	300	569	1240	540	339	232
5	1147	407	300	239	734	1040	771	85
9	1035	148	300	12191	11417	542	376	0
4	1119	303	300	1816	1872	332	233	148

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330 PASS40 AREA 5
     H    AMPS        V      TIME       FE        S       SI       AL       CA

                                   PYRITE
     4     360        4       300    10204    10419        0       72      145
     9     360        8       300     9458    10333       38        0        0
     7     362       11       300     9361     9209        0      147       14
     4     361        8       300     9703     9977        0        0       79
     4     361        3       300     9983    10477        0        0        0
     6     362        6       300     9528    10100       13       24        0
     7     361        6       300     9916     9928        0        0      216
     2     360       10       300    10142    10311       27      110        0
     4     362        9       300     9339     9744        0      271        0
                                   DATA
     1    1147      445       300      390      605      240      135        0
     1    1124      296       300      437     1037      553      300       15
     8    1087      331       300     1189     1365      614      550        0
     4    1068      240       300     1096     1225     1855     1519      190
     4    1123      342       300     1294     2426      332      244        0
     8    1085      250       300     4209     4662      737      594      158
     3    1111      359       300      850     1220      488      277       26
     2    1121      321       300      902     1376      409      338        0
     5    1111      340       300      815     1293      850      485      144
     2    1094      282       300      412     1014      722      394      317
     2    1123      294       300      895     1320      416      283        0
     7    1109      297       300     1170     1342      507      335        0
     6    1098      332       300     1948     1637      354      247      346
     4    1139      323       300      835     1050      307      258        0
     6    1122      442       300      405      849      395      226      328
     9    1043      296       300     3826     2548      393      293       31
     6    1116      293       300     1578     1928     1385      868      499
     4    1086      332       300      595      975      808      284       88
     6    1109      314       300      907     1242      434      264      159
     1    1104      271       300      778     1766      443      427      127
     2    1123      308       300      914     1585      663      359       59
     2    1146      385       300      748     1072      258      134       95
     3    1142      375       300      416      777      644      388       82
     3    1105      320       300      342      758      320      206       18
     2    1120      403       300      222      522      178       61      180
     4    1117      365       300      459     1153      463      311      359
     3    1121      314       300      159      700      464      312      157
     2    1124      382       300      333      800      654      439      101
     4    1100      251       300     1424     2188      656      430      211
     2    1098      296       300     1069     1653     1034      595      103
     1    1158      292       300      975     1695      810      675        0
     8    1088      321       300      554     1027      442      321        0
     1    1114      345       300      818      960     1010      713        5
     4    1113      319       300     1747     1630      414      263        0
     2    1094      416       300      448      831      361      142      164
     3    1113      284       300      504     1078     1253      260      263
     4    1096      339       300      690     1113      442      340        0
     4    1158      368       300      582     1381      437      261      105
     3    1145      245       300     2511     3030     1476      917      301
     4    1126      264       300     2925     3139     1133      771       74
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H	AMPS	V	TIME	FE	S	SI	AL	CA
1	1123	309	300	769	985	927	662	0
5	1128	307	300	259	495	355	202	212
3	1123	318	300	1172	1398	555	314	218
3	1120	252	300	1239	1566	1366	728	171
7	1113	307	300	2115	2436	373	225	84
2	1136	294	300	1067	1704	385	191	74
4	1115	230	300	4141	5262	909	598	312
2	1136	353	300	1025	1354	505	444	55
2	1109	285	300	1053	1646	686	493	0
1	1140	263	300	1195	1315	738	392	0
5	1143	248	300	3150	3404	984	788	189
2	1140	232	300	2773	2812	1539	1083	187
1	1102	354	300	776	1130	793	378	144
3	1161	431	300	223	307	134	33	195
4	1117	323	300	1753	2519	524	253	0
5	1095	286	300	1002	1056	455	155	140
4	1101	310	300	458	980	448	401	38
4	1141	382	300	167	701	411	375	44
3	1126	344	300	309	577	292	145	115
1	1140	330	300	812	1152	441	245	58
2	1100	284	300	2687	2996	385	265	92
3	1126	298	300	2044	2319	1699	636	305
3	1125	275	300	1312	1558	510	320	198
2	1155	335	300	502	870	468	246	13
3	1120	298	300	966	1593	526	443	70
3	1143	304	300	886	1320	600	333	159
5	1132	367	300	512	655	149	101	149
2	1134	392	300	718	880	344	187	78
2	1123	268	300	1038	1624	744	487	152
2	1169	391	300	344	732	232	54	99
4	1182	363	300	237	435	115	45	66
2	1095	448	300	147	506	51	64	47
3	1105	347	300	617	750	1106	517	2
3	1115	281	300	1920	2331	560	370	48
3	1150	416	300	190	530	156	92	150
5	1107	335	300	779	1156	814	670	276
1	1146	353	300	409	763	294	[illegible]	106
4	1118	281	300	1539	2054	191	173	210
4	1127	322	300	265	714	377	148	156
2	1141	331	300	512	952	501	278	0
1	1096	335	300	163	648	330	207	176
4	1107	271	300	3380	3964	858	692	123
3	1122	341	300	530	942	376	199	372
3	1141	358	300	710	1134	296	164	34
4	1108	277	300	740	1206	539	362	160
4	1118	374	300	37	469	263	91	0
4	1121	299	300	1314	1496	436	323	0
4	1098	346	300	819	1157	531	384	195
9	1108	278	300	2853	3616	532	358	0
3	1103	264	300	2652	3054	703	319	201
2	1107	325	300	651	761	305	202	188

7	1128	333	300	64	399	226	148	21
2	1111	296	300	1043	1184	890	308	308
3	1146	328	300	970	1207	578	331	238
5	1087	282	300	1005	1270	2901	1785	69
8	1115	350	300	1656	1855	235	146	169
1	1102	296	300	3325	3447	477	360	52
3	1127	330	300	520	810	281	173	224
5	1110	249	300	3704	4209	957	797	0
8	1021	177	300	12556	11637	1189	1066	257
2	1128	296	300	688	1339	537	400	0
2	1122	301	300	1140	1584	560	362	54
4	1110	350	300	284	666	345	167	12
1	1089	406	300	485	694	292	313	108
4	1137	379	300	282	611	696	158	74
5	1082	381	300	619	867	133	99	25
2	1123	328	300	806	1199	431	221	0
5	1124	290	300	1333	1681	667	444	0
1	1155	336	300	415	719	376	285	53
4	1123	272	300	1001	1381	1087	648	275
2	1136	367	300	799	1302	280	160	0
4	1135	391	300	301	686	297	241	170
2	1138	379	300	1125	1492	429	235	0
7	1144	350	300	2279	2927	206	218	31
4	1175	419	300	221	427	130	55	290
4	1136	364	300	193	399	848	606	0
1	1106	291	300	570	796	947	738	17
2	1109	312	300	1368	1940	708	481	232
5	1099	249	300	3842	4525	668	571	0
2	1122	371	300	945	1283	378	293	0
4	1112	347	300	539	906	697	229	185

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330 PASS 40 AREA 6
     H    AMPS        V     TIME      FE        S       SI      AL      CA

                                   PYRITE
     4     354        5      300    9727     9943        0       0     120
     2     355        6      300   10403    10133        0       0      17
     9     356        9      300    9443     9412        0     343       0
     6     355        5      300    9739     9412        0      73       0
     4     354        5      300    9827    10213       37      42      33
     6     357       11      300    9058     9580        0     103     190
     6     354        7      300    9672     9633       10     139       0
     4     354        7      300    9519     9760      104     115       0
     2     356        7      300    9775     9653        0     310       0
                                   DATA
     5    1160      322      300    1718     2238      600     477     289
     7    1128      305      300    2298     1918      614     406      29
     1    1139      313      300    1788     1679      593     405       0
     4    1130      314      300    1136     1357      167      81     159
     1    1157      312      300     383     1010      448     429       0
     5    1157      333      300     875     1242      840     452       0
     2    1141      343      300     789     1093      680     335       0
     6    1083      289      300    3269     2945      978     625     215
     5    1134      321      300     260      665      293     198      54
     3    1116      258      300    1625     1908      451     358     228
     2    1101      262      300     575     1014      988     636     337
     3    1126      300      300     755      860     1598     498      58
     5    1142      344      300     854      929      170     139       0
     4    1124      266      300     346      503     1293     839     255
     7    1109      409      300     283      601      251     151      51
     2    1143      334      300     651      971      248     107     465
     7    1148      342      300     555      780      803     439      25
     4    1138      334      300     657     1092      369     264     118
     7    1141      308      300    1614     1909      686     554     131
     4    1132      343      300     625      981      649     249     189
     4    1119      382      300     485      827      383     151      90
     0    1127      372      300    1534     1364      412     282      48
     4    1175      425      300     319      628       99       9     283
     5    1127      278      300    2340     2354     1013     604     108
     5    1128      253      300    2129     2252     1819    1189     491
     4    1158      384      300     752      964     1597     981      18
     2    1139      305      300    1041     1152      370     269      55
     2    1130      330      300     323      632      232     164     313
     4    1126      368      300     262      761      127     125     188
     4    1146      451      300     108      428      141      89     182
     2    1149      427      300     103      461      206      61     184
     2    1155      434      300     163      459      370     241     369
     0    1145      435      300     311      506      321     224     106
     2    1110      409      300     166      355      129     101     228
     2    1100      384      300     552      942      270       0       0
     1    1115      390      300     573     1126      676     449       0
     3    1133      366      300     384      785      482     301     314
     4    1137      362      300     287      448      312     205     132
     0    1096      289      300     943     1203      208     268     231
     4    1109      306      300    2351     2322      800     594      74
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H	AMPS	V	TIME	FE	S	SI	AL	CA
1	1136	365	300	749	1155	449	293	99
2	1136	360	300	1060	1395	783	245	0
4	1143	350	300	697	1093	1047	686	278
4	1113	333	300	567	703	3768	2228	0
5	1085	296	300	317	640	4748	987	87
2	1125	355	300	355	701	500	260	0
7	1155	458	300	312	476	241	130	84
3	1136	353	300	351	745	547	250	0
1	1137	315	300	1260	1671	332	277	0
2	1121	310	300	379	659	303	213	157
3	1153	299	300	280	604	381	228	271
4	1138	247	300	513	760	677	520	210
6	1129	349	300	358	957	357	136	107
4	1075	260	300	5770	4938	383	402	2311
2	1121	331	300	2906	2899	644	343	268
3	1090	362	300	534	1023	563	547	345
1	1127	324	300	1148	1360	522	414	203
4	1157	445	300	480	864	165	48	33
1	1150	360	300	926	1623	573	457	33
5	1102	220	300	3471	2964	809	608	40
6	1150	360	300	234	576	395	90	0
2	1128	315	300	276	451	156	123	121
2	1109	288	300	849	1225	262	194	197
3	1137	331	300	2944	2819	383	251	72
6	1150	336	300	943	1252	467	367	0
1	1140	395	300	718	1014	279	212	0
4	1145	392	300	990	954	479	333	304
3	1128	356	300	754	1038	181	134	358
7	1147	326	300	460	778	1065	937	0
2	1155	394	300	372	574	1023	232	0
2	1148	401	300	470	780	736	347	0
2	1132	326	300	484	1097	249	149	159
3	1132	234	300	1133	1550	1021	502	150
6	1144	323	300	1335	1328	355	321	384
6	1056	143	300	7776	7097	506	316	212
3	1180	449	300	555	782	248	147	0
4	1184	406	300	247	674	239	84	35
6	1167	456	300	59	567	178	23	184
2	1191	381	300	280	839	136	79	0
5	1186	360	300	203	823	281	128	70
5	1188	431	300	722	911	173	29	130
9	1153	380	300	1113	1744	365	295	352
4	1146	373	300	1262	1638	373	285	41
5	1137	326	300	858	1059	1233	292	0
4	1133	448	300	1339	1475	480	305	307
2	1134	411	300	174	486	280	153	240
6	1119	363	300	254	349	381	243	39
4	1140	368	300	441	730	369	388	0
5	1107	341	300	1075	1589	272	232	172
4	1129	327	300	1528	1822	716	470	158
1	1132	366	300	633	889	415	311	215

3	1130	326	300	701	850	2761	1520	497
1	1152	337	300	465	558	1191	814	88
7	1144	443	300	280	519	430	253	125
7	1177	383	300	321	612	299	236	0
3	1129	295	300	1019	955	460	257	82
3	1181	403	300	206	562	187	0	0
4	1189	434	300	120	449	235	156	0
1	1165	366	300	1575	2027	441	276	251
1	1186	415	300	204	733	354	293	129
3	1176	385	300	357	852	272	115	101
2	1163	415	300	465	769	292	123	73
1	1180	415	300	186	609	525	466	0
2	1109	357	300	422	608	1080	399	52
3	1064	370	300	192	433	522	255	0
2	1076	333	300	2520	3033	224	0	353
6	1075	378	300	516	589	410	253	0
3	1100	385	300	422	627	234	88	0
5	1065	265	300	977	1321	2566	1277	221
6	1070	364	300	760	1220	286	184	154
2	1064	316	300	789	954	872	565	0
3	1060	262	300	1362	2141	916	420	36
4	1083	354	300	1208	1628	501	340	144
4	1042	264	300	2916	2988	772	372	0
3	1032	169	300	1201	859	5669	2932	42
2	1063	310	300	620	927	862	472	0
4	1068	300	300	831	1398	495	319	57
4	1110	436	300	120	449	140	9	0
5	1098	320	300	1006	989	525	340	208
7	1100	358	300	559	769	619	393	0
0	1111	402	300	358	648	126	0	0

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330 PASS 40 AREA 7
    H    AMPS       V     TIME       FE         S        SI        AL        CA

                                 PYRITE
    4     354       5      300     9727      9943         0         0       120
    2     355       6      300    10403     10133         0         0        17
    9     356       9      300     9443      9412         0       343         0
    6     355       5      300     9739      9412         0        73         0
    4     354       5      300     9827     10213        37        42        33
    6     357      11      300     9058      9580         0       103       190
    6     354       7      300     9672      9633        10       139         0
    4     354       7      300     9519      9760       104       115         0
    2     356       7      300     9775      9653         0       310         0
                                 DATA
    8    1152     358      300      859       976       520       312       347
    2    1133     354      300      915      1232       687       388        94
    4    1101     249      300     1369      1157      3369      1910       185
    0    1179     359      300      555       924       334       248         0
    3    1112     394      300      356       519       203        64         0
    3    1150     289      300      537       960       462       355       276
    1    1169     334      300      396       779       166         9       236
    1    1158     384      300      355       634       162       103        36
    4    1120     326      300     1139      1624       645       241       255
    6    1147     365      300      615      1089       710       423         0
    1    1150     347      300     1107      1624      1027       739       113
    3    1133     452      300      936      1137       481       395        30
    5    1126     392      300      902      1300       585       463       186
    2    1135     297      300     1411      1825       729       528       118
    4    1156     320      300      427       801       770       540       246
    0    1136     336      300      589      1039       546       297       123
    6    1131     316      300      533       935       343       161        95
    3    1145     339      300      637       897       483       256         0
    7    1126     395      300      456       689       451       240       166
    3    1143     391      300      415       768       322       227       295
    2    1128     344      300     1104      1235       324        98       100
    2    1144     325      300      509       809      1288       630         0
    3    1119     391      300      665       932       963       988         0
    5    1136     376      300      656       819       345       242        66
    1    1197     502      300      253       239       120        93         0
    1    1160     374      300      220       567       605       271        60
    2    1133     340      300     1764      1647       641       359         0
    5    1159     413      300      448       508       267       151         3
    3    1132     369      300      701      1123       617       106        54
    4    1132     336      300      943      1099       509       379        51
    3    1146     312      300      770      1344       464       415       447
    3    1163     297      300      585      1038      2356      1630        13
    2    1191     422      300      403       673       274       120         0
    4    1184     451      300      700      1103       111        97         4
    0    1190     408      300      269       593       310       225       185
    1    1192     316      300      500       717       577       250       209
    3    1182     303      300      153       798       703       489       234
    2    1141     349      300     2842      3247       267       223         0
    4    1094     432      300     1395      1462       485       265        50
    1    1113     361      300      810       872       390       254        48
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H	AMPS	V	TIME	FE	S	SI	AL	CA
3	1141	462	300	206	466	365	156	32
0	1111	320	300	835	1038	469	283	283
7	1136	272	300	1065	1104	2376	1660	330
6	1078	236	300	5810	3626	463	478	356
4	1157	403	300	307	728	387	204	0
3	1151	329	300	1408	1142	458	276	270
2	1170	395	300	2381	3155	502	293	15
5	1118	239	300	9721	9048	943	760	62
2	1111	187	300	366	1013	4073	4151	144
2	1175	399	300	195	372	222	193	160
16	1091	302	300	7331	1310	428	222	0
4	1156	437	300	371	687	320	147	278
2	1119	449	300	450	639	324	161	18
4	1152	317	300	1356	1892	232	156	154
4	1180	397	300	350	793	420	404	0
2	1117	233	300	685	1656	2152	1972	153
6	1127	321	300	1643	1342	292	195	151
0	1141	409	300	410	800	199	53	200
3	1131	380	300	522	980	274	161	0
3	1123	365	300	670	875	783	436	294
5	1125	292	300	1389	1941	845	490	46
2	1148	314	300	1202	1445	486	231	44
4	1119	295	300	840	1091	906	316	0
3	1096	249	300	6372	4947	470	337	81
5	1022	123	300	16843	14896	911	459	0
5	1112	317	300	2608	3072	605	415	0
2	1142	410	300	1036	1587	395	303	118
5	1153	420	300	398	808	353	228	244
3	1136	366	300	1614	1753	213	213	114
5	1128	368	300	3698	3953	492	394	0
3	1086	243	300	7858	7545	597	444	3
5	1080	373	300	1317	1353	1216	777	281
4	1141	351	300	2197	2069	293	194	0
7	1117	307	300	1356	1826	1367	1086	486
4	1132	289	300	511	955	613	108	336
4	1146	344	300	677	736	865	260	69
2	1133	314	300	520	838	519	328	354
3	1126	384	300	1458	1770	324	265	2
2	1119	346	300	1421	1542	387	311	18
4	1149	377	300	152	611	386	253	13
3	1115	361	300	444	744	350	193	1649
1	1164	405	300	399	830	289	126	197
2	1119	453	300	503	914	267	150	265
4	1145	444	300	381	747	513	325	221
2	1171	430	300	195	447	109	108	157
5	1154	447	300	336	747	373	240	324
5	1163	422	300	516	646	929	319	124
4	1138	388	300	61	454	340	235	0
5	1156	426	300	415	835	374	262	38
2	1151	450	300	564	847	347	267	0
3	1128	497	300	508	747	448	207	293

3	1135	388	300	326	706	751	319	157
3	1137	378	300	359	766	315	285	0
4	1129	401	300	506	778	279	134	16
5	1112	386	300	648	864	376	124	0
3	1141	406	300	348	590	417	182	304
2	1052	247	300	1308	1273	3173	3137	273
4	1061	207	300	926	921	6487	5937	335
2	1143	392	300	418	597	265	113	128
6	1106	283	300	619	923	494	361	100
3	1106	328	300	1127	1232	491	293	484
3	1163	374	300	635	1083	487	341	54
3	1139	340	300	346	759	406	283	0
8	1129	307	300	1152	1684	1657	1263	403
1	1175	457	300	163	521	256	152	15
2	1139	385	300	1048	1340	392	97	260
6	972	129	300	17032	14943	32	0	138
1	1104	356	300	1247	1761	560	412	62
3	1106	462	300	218	548	214	107	0
2	1170	546	300	210	508	129	84	238
6	1128	373	300	319	692	759	449	79
1	1102	398	300	419	696	577	407	1
4	1147	282	300	543	648	496	477	364
1	1123	553	300	240	420	66	98	159
4	1134	355	300	1051	1417	780	423	37
2	1117	362	300	1467	1876	680	506	0
5	1130	416	300	1365	1513	495	396	0
4	1138	413	300	325	753	253	221	14
2	1160	353	300	798	1162	545	519	138
7	1154	360	300	587	945	429	278	127
2	1162	398	300	442	779	291	105	29

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330 PASS 40 AREA 8
        H    AMPS       V     TIME      FE       S      SI      AL      CA

                                    PYRITE
        3     363       7      300    9881    9929       0       0       0
        2     363       6      300    9679   10268      12      39     248
        6     364       7      300    9697    9515     131     445     256
        5     363       8      300    9455   10125       0       0       0
        4     362       7      300   10009   10426       0       0       0
        3     364       9      300    9698    9849       0       0     159
        1     363       9      300   10103   10445       0     225      37
        3     362       8      300   10135   10162      64       0       0
        7     363       9      300    9425    9775      28     134       0
                                                        65     212       0
                                    DATA
        7    1128     257      300    2094    2536    1027     537      48
        4    1116     168      300     979    1433     658     492       0
        6    1133     292      300     697    1223     537     335      74
        6    1148     329      300     915    1101     681     397       0
        6    1085     216      300    6935    6243     371     301       0
        7    1143     230      300    2310    2085     515     322       0
        7    1111     379      300    2468    2562     314     202       0
        5    1042     230      300    8969    7577     892     334     271
        6    1026     126      300   13631   12535     344     229       0
        6    1085     300      300    4326    4404     900     610     166
        4    1130     274      300    2892    2373     421     223      25
        4    1141     383      300     310     770     592     477      10
        3    1133     286      300     941    2011     429     400       0
        4    1118     354      300    3323    3374     568     306     187
        4    1111     476      300     225     451     167      32       0
        5    1159     337      300     386     698     284     181      40
        5    1122     209      300    6155    6114     694     579     178
        3    1156     376      300     230     618     361     111     240
        0    1108     333      300     402     646     261     186       0
        9    1128     260      300    2413    2900     800     630     204
        4    1143     290      300     742    1107    1217     955     174
        7    1141     362      300     820     981    1490    1040     411
        1    1109     262      300    1332    1543     972     601       0
        5    1148     312      300     589     855     350     316      63
        7    1129     328      300    2936    3003     565     588     182
        3    1165     313      300     835     984     643     567     113
        4    1172     384      300     878    1029     145      77      15
        3    1146     359      300    1132    1635     652     216     221
        5    1146     312      300     976    1537    1870    1296     148
        4    1130     265      300    2936    3043    1964    1678       0
        2    1151     375      300     270     462     253     154       0
        3    1142     414      300     358     427     141      24     122
        8    1128     409      300     694    1022     308     183       0
        6    1136     350      300     472    1048     866     347     340
        4    1105     362      300     482     796     290     190       0
        2    1157     353      300     378     758     266      22       0
        5    1180     383      300     533     738     515     178     244
        8    1164     396      300     337     626     270     245      28
        7    1147     303      300    2158    2343    1247     979      56
        5    1152     302      300     334     809    1224     766     102
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H	AMPS	V	TIME	FE	S	SI	AL	CA
5	1166	366	300	246	355	195	142	103
5	1152	376	300	367	546	412	281	232
4	1112	303	300	1068	1738	470	648	28
2	1144	393	300	526	667	172	184	169
11	1106	282	300	1200	1440	1481	511	59
2	1102	300	300	2432	2955	871	606	0
4	1127	323	300	864	1393	523	428	164
1	1140	400	300	300	699	444	265	306
2	1123	319	300	887	1007	1481	1200	0
9	1123	251	300	2576	2183	570	370	26
2	1127	381	300	333	778	275	212	53
2	1130	361	300	924	1112	335	308	93
1	1117	399	300	825	1026	830	781	0
4	1155	328	300	2198	2140	277	23	95
7	1148	383	300	547	657	404	4	0
1	1094	361	300	377	595	219	172	0
5	1144	298	300	592	913	403	200	0
6	1143	324	300	987	1368	369	215	93
4	1123	358	300	199	779	20	11	46
1	1154	295	300	99	844	153	244	0
5	1123	317	300	1468	1847	361	187	0
3	1173	248	300	654	906	830	401	35
4	1109	329	300	885	1188	899	539	107
0	1147	364	300	557	847	227	207	81
2	1146	435	300	356	600	232	97	210
2	1168	458	300	175	347	183	146	0
3	1128	368	300	783	1086	412	316	0
3	1140	331	300	748	1103	502	280	107
2	1120	398	300	626	1157	683	356	118
3	1115	462	300	208	635	390	370	219
8	1134	441	300	583	709	499	284	51
3	1126	379	300	694	1371	286	250	0
1	1106	297	300	823	1142	360	301	70
2	1102	253	300	2921	2912	551	382	0
3	1121	414	300	244	454	140	194	0
8	1151	358	300	581	732	217	81	166
5	1101	356	300	492	729	200	138	0
4	1142	292	300	2537	2738	746	560	429
3	1110	305	300	511	1029	459	319	0
4	1060	257	300	1258	1465	410	202	0
3	1097	395	300	428	829	321	243	120
1	1142	340	300	125	511	285	308	247
3	1125	393	300	481	681	485	294	193
2	1119	421	300	585	1145	866	658	65
2	1109	342	300	593	1555	502	569	20
2	1120	531	300	266	604	179	110	159
2	1132	386	300	950	735	454	319	180
3	1119	392	300	1287	1400	339	181	88
5	1161	358	300	574	693	305	335	0
3	1139	300	300	1689	1583	514	424	114
3	1114	397	300	993	926	607	518	0

3	1134	427	300	318	514	150	71	151
4	1146	351	300	362	846	529	381	0
5	1159	428	300	789	1028	465	265	33
1	1138	430	300	249	370	215	129	0
6	1120	316	300	1765	2028	722	394	92
6	1129	319	300	1232	1716	518	182	359
2	1037	242	300	1290	1562	482	403	213
4	1037	274	300	1321	1935	703	339	148
8	1032	194	300	1932	2206	1127	835	0
1	1140	371	300	821	1299	570	387	344
1	1108	449	300	665	844	488	460	155
5	1079	455	300	897	978	323	232	0
5	1137	375	300	583	1078	360	266	34
5	1152	443	300	175	512	358	348	97
6	1119	370	300	728	943	434	219	100
4	1102	309	300	1814	2021	411	287	12
3	1079	397	300	560	769	292	227	0
4	1126	374	300	527	525	431	297	0
3	1122	379	300	308	636	195	135	216
4	1066	362	300	308	523	251	104	249
7	1112	295	300	1618	1944	237	178	0
1	1119	260	300	759	977	468	355	100
1	1129	337	300	508	700	237	162	4
3	1116	355	300	640	729	342	216	25
3	1118	319	300	717	1566	1151	822	298
1	1125	278	300	909	1064	1820	839	264
2	1139	392	300	697	931	379	159	63
4	1141	321	300	610	1026	515	521	138
4	1056	345	300	828	1185	750	526	171
3	1080	373	300	874	1148	382	252	238

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308 PASS 40 AREA 1
      H    AMPS       V     TIME      FE        S       SI       AL       CA

                                   PYRITE
      5     360       4      300     9941    10039      33        1        0
     10     360       3      300    10008     9837       0        0        0
     12     360       8      300     9744    10163       0        0        0
     10     360       3      300    10238    10203       0        0       78
      5     361       5      300     9728    10445       0       17      186
      9     361       3      300     9630    10080       0        0       75
      5     360       2      300     9631     9979       0       30        0
      5     361       1      300     9471     8940       0        0        0
      9     359       3      300     9619    10059       0      250        0
                                                            0        0      110
                                   DATA
      3    1134       1      300     1098     1815     955      717      217
      2    1182       6      300      435     1136     400      285      181
      3    1153       3      300      771     1594     675      539       95
      5    1160       4      300      431     1333    1629      835      261
      6    1176       8      300     1415     1942    1287      862      220
      7    1117       3      300      822     1215    2603     2189      157
      5    1126       2      300      787     1372     784      506      496
     10    1181       4      300      632     1105     824      821      106
      4    1164       3      300      401      764    1401     1650      172
      3    1168       4      300      368     1244     263      327        0
      2    1158       2      300      683     1044     391      410      394
      7    1194       3      300      396      844     360      239        0
      3    1193       5      300      378      822     382      242      251
      5    1220       5      300      495      850     389      310       82
      2    1188       2      300      258      668     112      100        0
      1    1168       2      300      928     1431     263      190       39
      3    1168       4      300      514     1160     723      528        0
      3    1177       7      300      580      975     471      359       51
      6    1126       3      300      809     1218     477      319       44
      7    1195       7      300      310     1194     297      197        0
      7    1124       2      300      541     1612    1113     1110      213
      5    1144       2      300      556     1210     542      377      160
      5    1205       2      300      292     1162     320      265       73
      4    1204       4      300      337     1114     442      306       31
      2    1118       5      300      224      986     489      247      160
      2    1102       3      300      441      760     258      183        0
      9    1059       6      300      769     1357     702      306      236
      4    1109       1      300      684     1068     637      347      212
      4    1091       6      300      266     1100     750      342      187
      7    1038       4      300     1227     1223    1089      566      487
      8    1075       4      300      494     1219     219      116      173
      5    1142       3      300      230      998     234      275       74
      2    1137       4      300      210     1018      71        0      324
      2    1101       4      300      252     1179     179      123       49
      1    1114       2      300      109     1046      43       55      192
      3    1132       3      300      129      966      58        3      144
      6    1157       2      300       29      793     107       84      264
      4    1154       2      300      181     1069     182      116      487
      7    1043       1      300     1658     1877     966      596      106
     11     996       3      300      971     1430    2949     1468      107
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H	AMPS	V	TIME	FE	S	SI	AL	CA
8	1085	1	300	318	1051	497	387	398
6	1064	8	300	425	1252	670	474	289
4	1045	4	300	728	1301	825	742	623
8	1141	3	300	307	1154	1270	959	131
1	1117	4	300	1063	1695	1002	702	0
5	1062	3	300	595	1196	525	370	137
8	1105	2	300	358	1509	491	344	198
4	1076	3	300	1267	1491	1773	1036	170
6	1064	2	300	1064	938	1031	520	67
4	1038	9	300	643	1643	1154	1080	0
6	1083	4	300	669	1602	1518	1231	206
9	1104	1	300	598	1355	944	576	0
5	1085	3	300	802	1443	509	313	480
3	1124	2	300	676	1209	274	205	227
5	1176	5	300	198	928	101	78	83
4	1068	4	300	275	988	290	211	65
8	1054	3	300	2194	2210	582	399	395
8	1109	4	300	898	1434	1761	1180	62
6	1127	2	300	409	1249	1590	1207	245
7	1104	7	300	555	1444	1418	1190	0
5	1142	6	300	649	1524	1099	623	285
9	1093	3	300	1573	1884	628	374	0
3	1081	3	300	1051	1315	622	293	387
6	1079	1	300	1418	1192	635	491	419
4	1074	0	300	663	1129	563	340	50
7	1115	4	300	1144	1663	1270	958	56
6	1110	5	300	615	1338	966	873	0
3	1144	3	300	703	1322	140	77	230
2	1142	3	300	319	1090	194	235	381
2	1132	5	300	367	738	223	126	0
5	1079	2	300	463	1154	243	220	278
7	1054	9	300	548	1292	483	341	161
6	1082	3	300	1771	1977	757	426	283
5	1094	6	300	1539	2059	2176	1524	0
3	1148	2	300	849	1715	929	551	0
2	1121	1	300	885	1550	748	510	313
6	1141	2	300	453	1631	1553	934	102
2	1052	0	300	1608	2706	1025	1511	239
5	1096	2	300	868	1237	717	421	120
1	1133	3	300	378	1422	743	521	161
8	1066	3	300	881	3066	1083	1680	102
0	1032	1	300	929	1761	1846	1557	29
6	1091	3	300	944	1360	1736	1118	119
4	1061	3	300	637	1168	687	385	189
4	1092	1	300	389	1104	226	93	236
5	1069	4	300	839	1272	407	127	113
10	1093	2	300	467	1675	394	176	153
3	1079	5	300	1260	1904	652	565	183
6	1060	1	300	2122	1566	517	244	351
5	1085	2	300	1316	1456	622	508	0
6	1138	2	300	423	1056	392	260	0

8	1119	7	300	600	1230	413	364	138
3	1080	5	300	679	1063	293	168	271
10	1079	4	300	1418	1486	929	685	256
9	1065	5	300	1290	1667	594	404	216
9	1060	5	300	2298	2295	1129	897	194
6	1081	2	300	1473	1918	914	687	299
5	1048	1	300	4872	4692	646	706	8
2	1125	3	300	536	1324	667	509	182
7	1069	1	300	910	1220	801	501	119
5	1113	2	300	1398	1924	650	568	0
3	1022	4	300	1371	1863	1350	969	116
1	1028	14	300	3480	3106	133	23	30
3	1093	4	300	2438	2819	418	328	57
3	1055	2	300	2295	2231	701	565	122
5	1039	5	300	1783	1681	1301	905	269
4	1134	4	300	526	1044	439	220	194
4	1154	3	300	289	726	220	192	137
6	1133	1	300	721	983	622	349	123
3	1149	4	300	364	719	771	336	0
1	1149	3	300	315	836	298	277	0
4	1143	2	300	412	1082	736	684	60
9	1117	6	300	531	1027	489	453	142
2	1116	2	300	471	1104	434	391	232
3	1114	3	300	727	1165	575	347	46
8	1144	4	300	304	837	132	110	111
4	1117	1	300	328	811	145	90	155
5	1082	5	300	503	1406	903	434	0
8	1088	6	300	1263	1801	451	224	0
6	1094	3	300	1893	2379	411	331	162
3	1103	5	300	1264	1596	383	238	154

308 PASS 40 AREA 2

H	AMPS	V	TIME	FE	S	SI	AL	CA
				PYRITE				
4	364	2	300	9610	9978	0	0	205
6	363	5	300	9823	10074	0	96	0
11	363	2	300	9778	9922	0	0	157
15	363	7	300	10030	10091	64	0	84
4	363	1	300	9403	10388	74	146	222
8	363	3	300	10045	10187	32	0	0
10	364	1	300	9995	9897	41	0	108
5	364	1	300	8706	9278	0	51	275
3	363	1	300	9755	10057	0	0	0
				DATA				
4	1115	2	300	2422	3005	1865	951	0
7	1125	8	300	1081	4243	79	1699	341
5	1115	2	300	2455	2523	464	409	295
8	1136	5	300	359	867	623	503	140
2	1154	5	300	1121	1931	429	407	64
7	1137	2	300	420	1733	439	218	49
6	1125	6	300	1820	1571	400	51	0
6	1119	2	300	1250	1559	868	538	297
5	1136	2	300	698	1252	403	195	105
8	1124	3	300	654	1342	172	201	131
9	1110	7	300	589	1209	620	459	227
8	1146	4	300	845	1351	1010	614	106
7	1173	2	300	326	786	2438	2201	0
8	1115	4	300	2116	1965	1445	1369	193
8	1140	1	300	346	1269	345	273	220
2	1133	5	300	1000	936	580	309	803
4	1113	2	300	1318	1416	1021	1019	219
8	1143	3	300	1275	2203	41	114	2
4	1111	5	300	741	1582	696	547	107
4	1129	2	300	1379	2238	831	745	92
10	1125	6	300	1004	2153	490	476	377
6	1091	4	300	3011	4126	458	671	407
10	1097	0	300	2015	7860	254	3915	34
3	1110	1	300	542	1904	2492	1325	0
7	1066	2	300	6773	6493	644	543	73
7	1132	2	300	2569	3609	993	1047	368
8	1105	2	300	1278	2113	554	501	247
1	1128	8	300	242	1813	656	618	354
4	1135	5	300	370	1523	612	445	12
3	1140	2	300	665	1628	457	231	237
5	1121	6	300	2087	2115	558	330	459
2	1120	7	300	616	1577	286	318	0
2	1073	4	300	3001	2166	473	632	195
13	1104	9	300	481	1893	3183	3368	266
5	1168	6	300	266	805	172	76	0
6	1144	1	300	572	1078	228	255	197
4	1126	3	300	914	1782	582	271	246
5	1115	3	300	1274	2310	256	234	264
4	1179	7	300	364	862	140	126	500
9	1124	1	300	701	1182	168	119	267

H	AMPS	V	TIME	FE	S	SI	AL	CA
2	1175	10	300	137	1810	712	483	
6	1112	4	300	1843	2365	669	498	0
2	1114	5	300	677	1942	294	358	385
4	1110	1	300	625	1447	707	260	185
4	1061	2	300	878	1575	821	607	27
7	1131	3	300	377	1676	509	266	173
1	1127	4	300	590	1257	327	240	0
6	1124	4	300	352	949	216	177	325
9	1128	1	300	481	1597	177	173	203
9	1099	5	300	1612	2286	357	218	464
4	1147	3	300	384	885	44	157	0
0	1172	4	300	226	775	95	76	19
5	1147	5	300	397	1057	151	172	283
5	1135	2	300	309	841	415	436	233
7	1157	4	300	386	1057	318	247	17
4	1133	6	300	828	840	330	235	184
3	1113	1	300	397	1076	720	332	213
6	1106	6	300	651	1412	663	424	177
4	1108	8	300	383	1232	386	226	45
2	1155	5	300	361	943	191	173	196
1	1168	4	300	336	949	179	302	207
6	1109	7	300	1803	1997	746	478	17
4	1108	3	300	413	1135	922	688	35
6	1127	1	300	227	1272	66	70	943
2	1159	6	300	178	1231	143	83	24
9	1100	2	300	2420	2284	616	461	251
5	1126	0	300	776	1429	1091	642	218
2	1154	3	300	685	2006	139	281	0
1	1138	4	300	232	1223	141	90	233
3	1122	8	300	200	1130	244	191	297
2	1096	4	300	643	1142	641	155	212
7	1136	4	300	965	1571	209	198	43
6	987	7	300	13641	11406	1551	1328	292
3	1074	1	300	1256	1996	1179	703	0
3	1138	11	300	408	1135	452	370	96
4	1101	3	300	1373	1546	408	280	1028
6	1141	2	300	415	758	487	320	45
2	1159	3	300	762	1344	558	494	43
4	1156	6	300	411	690	620	306	180
1	1168	3	300	792	717	564	338	275
6	1211	1	300	438	903	746	565	235
4	1043	4	300	760	1003	298	221	18
5	1033	1	300	6037	3838	524	557	0
14	1046	2	300	6743	4339	725	606	0
9	1095	4	300	2042	1955	356	205	1
3	1178	5	300	286	1176	218	129	390
4	1189	0	300	433	1398	128	110	260
7	1099	6	300	418	1134	595	272	284
2	1152	5	300	458	1390	463	356	295
2	1169	5	300	198	933	328	260	0
4	1077	5	300	1343	1033	6532	2695	0
								811

7	1084	3	300	1789	1747	2556	1177	575
3	1118	6	300	444	811	495	193	200
3	1122	2	300	501	817	271	174	117
5	1114	2	300	990	1386	393	260	0
6	1183	0	300	494	1170	182	167	318
4	1149	1	300	606	1387	390	560	71
3	1124	2	300	312	790	334	260	126
1	1231	4	300	327	435	1569	1390	0
2	1229	8	300	260	408	794	790	24
2	1228	6	300	372	843	562	428	0
8	1105	3	300	537	1158	1073	799	0
5	1161	1	300	697	1137	572	501	248
2	1126	2	300	748	1632	569	306	120
10	1125	4	300	2475	3405	475	403	107
4	1142	0	300	761	1603	615	508	217
2	1142	3	300	547	740	101	93	32
7	1161	3	300	254	628	81	78	376
5	1094	4	300	770	1127	4021	2439	106
7	1128	2	300	1138	827	6645	2729	423
6	1146	4	300	1128	1502	1886	1489	389
8	1077	3	300	1997	2008	4794	4335	221
5	1101	3	300	481	1575	1839	929	35
4	1127	8	300	356	1113	652	428	331
3	1103	2	300	669	1228	476	371	830
5	1119	2	300	1756	1606	117	42	0
4	1146	4	300	1181	1923	234	87	120
8	1073	4	300	3494	2980	496	414	55
8	1127	2	300	3816	3832	1383	992	95
6	1118	0	300	958	1648	1409	1265	347
6	1170	2	300	512	1045	576	494	337

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308 PASS 40 AREA 3
   H    AMPS      V    TIME       FE        S      SI      AL      CA

                              PYRITE
   4     364      2     300     9610     9978       0       0     205
   6     363      5     300     9823    10074       0      96       0
  11     363      2     300     9778     9922       0       0     157
  15     363      7     300    10030    10091      64       0      84
   4     363      1     300     9403    10388      74     146     222
   8     363      3     300    10045    10187      32       0       0
  10     364      1     300     9995     9897      41       0     108
   5     364      1     300     8706     9278       0       0     108
   3     363      1     300     9755    10057       0      51     275
                              DATA
   5    1179      4     300      463     1379     313     245      95
   5    1087      2     300      593     1526     521     307      25
   5    1109      3     300      554     1101     350     407       0
   3    1105      5     300      239     1009     138      66     102
   5    1131      4     300      107     1108     174     157     134
   6    1046      3     300     1340     1539     746     725     232
   6    1019      5     300     3748     2876    2143    1678     219
   6    1059      6     300     1433     1700    1111     897     374
   6    1043      4     300     3157     3060    2142    1293     293
   2    1088      1     300      864     1442    1549    1299     196
   8    1104      0     300     1370     1587     709     534     142
   5    1117      5     300      544      809     494     488     284
   6    1116      4     300      822     1261     497     453     395
   2    1129      5     300      571     1130     376     249     205
   1    1103      3     300      366      858     227     160     123
   3    1110      4     300     1088     1165     491     467     306
   4    1064      3     300      532     1046     453     496     261
   3    1029      2     300      612      827     388     296       0
   6    1082      1     300      424      903     838     646     118
   1    1125      4     300      241     1144     126      16       0
   5    1060      1     300      438     1292     454     353      75
   7    1058      2     300      735     1561    1323     950     234
   4    1096      3     300      865     1524    1634    1441     142
   7    1076      4     300      468      947    1703    1485       0
   6    1099      5     300      595     1229    1396    1296      55
   5    1059      3     300      676     1209     797     470     222
   8    1099      3     300      415     1086     681     707     283
   0    1094      1     300      399      837    1285    1454       3
   7    1061      4     300      635      991     743     720     135
   3    1084      7     300      498      956     982    1077      13
   3    1103      4     300      423      743     420     490       0
   2    1105      0     300      532      922     313     220       0
   3    1098      3     300      252      851     188     136     525
   5    1086      3     300      286      951     117     154       0
   4    1063      1     300     2077     2106     698     529      75
   5    1073      4     300      668      932    1432    1343     319
   1    1130      2     300      284      766     146       0      76
   4    1093      5     300      725     1055     387     304     245
   4    1049      6     300     1282     1831     403     283      55
   4    1052      0     300     1664     2450     287     162       0
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H	AMPS	V	TIME	FE	S	SI	AL	CA
7	1095	3	300	833	1546	856	637	236
2	1094	5	300	691	1591	628	474	349
4	1096	1	300	2098	2386	313	361	228
6	1074	2	300	928	1485	471	325	279
5	1084	4	300	1244	1889	540	396	149
3	1062	0	300	1185	1454	423	418	457
6	1097	0	300	1178	1616	310	237	238
4	1123	4	300	834	1200	276	94	68
2	1130	1	300	1134	1512	122	97	168
3	1130	2	300	890	1313	179	238	0
3	1118	1	300	114	1073	179	173	221
5	1113	7	300	378	1215	101	72	149
3	1067	1	300	550	1103	388	257	198
8	1035	3	300	848	1207	1041	948	224
3	1049	1	300	1069	1968	355	307	332
5	1043	1	300	457	1542	239	234	166
4	1104	3	300	441	1342	276	104	60
3	1117	5	300	137	960	336	281	366
7	1088	5	300	528	1521	442	334	192
5	1089	2	300	77	1616	783	673	326
3	1041	3	300	301	1273	461	212	312
2	1103	2	300	668	1356	434	397	11
4	1140	3	300	969	1262	530	416	29
5	1090	5	300	945	1538	407	325	409
5	1075	3	300	647	1581	476	321	0
4	1088	4	300	1538	2433	1348	1043	221
10	1109	6	300	476	1508	959	695	343
4	1058	1	300	784	1125	531	462	53
3	1106	3	300	298	1050	269	290	222
1	1131	7	300	290	1309	486	261	149
6	1147	5	300	208	1194	407	246	0
4	1139	5	300	247	1230	115	105	184
6	1065	2	300	2693	2357	400	338	266
5	1106	3	300	1481	1771	838	355	0
3	1063	1	300	334	1227	628	589	0
1	1098	3	300	353	1708	384	380	147
4	1112	0	300	225	1318	451	354	499
8	1093	5	300	536	1337	219	122	197
5	1094	1	300	252	1030	792	742	162
1	1097	4	300	446	1186	1205	1064	76
2	1064	2	300	509	1198	493	471	139
5	1090	4	300	632	1191	448	345	257
5	1115	2	300	398	1139	213	127	0
6	1067	6	300	583	1234	674	1035	288
4	1142	4	300	158	1170	218	221	38
4	1116	6	300	295	1593	202	189	172
2	1116	2	300	577	1307	430	263	0
6	1100	3	300	989	1514	371	266	333
7	1090	2	300	778	1525	630	556	60
5	1083	4	300	856	1390	465	303	23
2	1095	2	300	1210	1527	235	145	92

2	1140	3	300	236	1239	179	215	74
6	1142	0	300	322	970	362	437	0
5	1132	4	300	402	1137	369	345	304
2	1103	5	300	573	1172	331	163	77
8	1084	3	300	1096	1230	257	158	18
3	1075	3	300	704	1352	436	446	257
5	1117	2	300	492	1456	192	356	0
9	1124	2	300	413	1260	938	494	56
4	1085	0	300	791	1616	1984	1849	358
2	1103	7	300	451	1095	339	85	363
3	1089	3	300	565	941	298	253	335
6	1095	3	300	1118	1550	282	277	23
5	1094	5	300	581	1167	307	329	217
5	1070	2	300	1686	1976	70	38	72
6	1123	3	300	525	1162	136	73	37
6	1086	0	300	945	1600	323	285	220
4	1137	1	300	156	1519	493	316	0
6	1095	2	300	760	1552	418	242	0
3	1093	7	300	534	818	495	398	126
2	1113	3	300	544	1055	222	140	244
4	1117	2	300	527	886	553	396	162
3	1090	2	300	434	1062	483	523	189
7	1133	1	300	285	1268	401	446	379
1	1122	3	300	948	1998	258	175	96
4	1041	1	300	1718	2027	565	406	43
5	1113	3	300	368	1187	481	434	0
8	1045	5	300	1524	1795	2056	752	60
3	1094	2	300	1899	2554	262	163	59
10	1100	9	300	1719	2128	238	298	66
5	1107	2	300	649	1128	293	239	199

308 PASS 40 AREA 4

H	AMPS	V	TIME	FE	S	SI	AL	CA
				PYRITE				
11	360	2	300	9676	9883	0	15	112
4	360	3	300	10128	10141	0	0	0
4	360	7	300	10049	9821	0	0	249
5	360	3	300	10012	10161	58	0	38
12	360	5	300	10264	10205	16	58	196
5	359	1	300	10276	9931	10	0	0
14	360	1	300	9932	9710	0	0	0
9	361	2	300	9397	9111	66	284	177
7	358	2	300	10045	10222	0	0	233
				DATA				
4	1108	2	300	385	1220	1147	966	39
6	1054	5	300	495	1150	870	684	274
5	1097	3	300	508	1058	371	200	330
4	1100	6	300	288	1026	345	252	478
4	1081	2	300	689	1007	412	382	258
2	1088	0	300	118	689	173	155	246
4	1124	5	300	270	884	284	156	59
3	1112	5	300	528	944	195	35	0
6	1054	4	300	1713	1454	887	824	150
12	1092	3	300	1203	1741	1050	609	18
2	1134	3	300	310	988	414	407	69
8	1069	3	300	679	1267	428	335	390
5	1084	3	300	424	1083	349	272	478
4	1075	2	300	981	1123	305	292	428
4	1093	2	300	311	1022	322	167	240
3	1097	3	300	842	1391	617	517	257
5	1056	2	300	877	1531	401	338	77
5	1062	3	300	628	1024	476	620	52
4	1072	0	300	351	775	97	130	127
4	1106	7	300	866	1131	295	242	361
6	1108	5	300	244	734	641	373	270
4	1103	7	300	346	858	333	237	807
8	1018	2	300	3450	2946	729	446	22
11	1031	4	300	4378	4650	1088	795	1036
3	1075	2	300	748	1181	366	329	243
1	1116	4	300	345	700	230	320	220
2	1119	1	300	651	1045	361	342	90
4	1109	5	300	365	772	848	100	75
7	1066	1	300	1417	1507	374	294	87
9	1076	2	300	831	1605	806	672	0
6	1108	2	300	434	1076	737	548	49
4	1088	2	300	754	1174	946	402	178
5	1040	4	300	1081	1674	750	419	391
4	1122	3	300	463	1391	279	213	42
11	1025	5	300	9057	8914	115	0	0
8	1059	6	300	4458	5018	301	21	73
4	1076	4	300	1507	1684	2754	2368	215
9	1112	5	300	523	811	893	919	240
6	1097	4	300	256	1006	692	561	71
12	1057	5	300	3746	3927	303	206	372

H	AMPS	V	TIME	FE	S	SI	AL	CA
3	1056	3	300	378	1206	493	586	124
4	1095	2	300	868	1189	703	233	0
5	1083	4	300	965	1304	457	360	265
7	1074	2	300	1245	1425	802	497	184
6	1115	4	300	400	877	143	61	0
5	1096	4	300	62	811	311	173	378
10	1121	2	300	373	904	681	632	0
2	1074	0	300	1187	1726	620	538	365
8	1095	3	300	1316	1595	1676	1476	432
3	1098	2	300	830	1194	395	306	126
2	1089	1	300	492	1296	452	450	201
5	1072	3	300	408	1108	585	534	282
8	1096	4	300	1612	1869	2325	1638	358
1	1094	3	300	847	1598	2038	1264	457
3	1120	1	300	250	1071	2263	1938	64
7	1097	4	300	5210	5018	362	358	171
6	1116	2	300	1029	1865	483	367	362
5	1129	3	300	271	1214	701	386	197
10	1102	2	300	1044	1808	1833	1560	391
10	1111	2	300	1452	1913	551	491	586
4	1111	2	300	840	1480	649	528	257
2	1116	2	300	680	1355	989	984	632
10	1113	2	300	1357	1658	1181	718	293
6	1093	1	300	2279	2502	879	696	952
10	1072	4	300	983	1464	633	495	430
7	1071	6	300	1421	1419	389	218	98
4	1097	6	300	258	977	334	184	106
7	1045	4	300	3626	3808	649	584	252
5	1053	3	300	417	1101	878	519	317
4	1116	5	300	481	1066	434	391	34
2	1125	5	300	450	979	387	307	320
4	1130	9	300	1153	1661	295	233	150
11	1112	4	300	1015	1401	790	919	0
3	1101	1	300	1526	1982	495	309	406
5	1123	6	300	1266	1748	623	469	182
5	1122	4	300	982	1490	579	404	469
8	1120	3	300	1172	1860	681	593	377
5	1112	3	300	918	1823	668	481	50
4	1075	3	300	556	1685	828	562	177
8	1114	9	300	1586	1941	384	437	13
8	1085	2	300	781	1427	533	436	0
2	1101	5	300	197	820	201	208	121
5	1085	2	300	341	745	817	670	123
2	1113	3	300	159	797	491	235	305
4	1134	7	300	268	735	459	345	85
5	1128	6	300	192	834	551	396	82
4	1111	2	300	232	804	619	493	0
4	1065	3	300	1203	1307	529	374	72
8	1061	3	300	2512	2156	198	59	291
9	1109	2	300	2167	2650	114	177	147
7	1064	1	300	2606	2972	1320	1093	244

6	1098	2	300	646	1163	254	275	181
6	1125	2	300	817	1000	210	156	448
4	1061	3	300	232	673	151	126	125
4	1117	3	300	297	645	240	90	141
3	1068	1	300	510	841	388	263	0
2	1124	4	300	48	829	302	117	46
8	1051	6	300	1201	1495	539	358	0
11	1069	2	300	1262	1865	663	480	0
7	1095	7	300	636	1370	320	252	255
6	1114	0	300	202	828	380	384	239
5	1046	2	300	69	937	275	245	220
4	1075	3	300	466	945	660	271	21
5	1110	2	300	714	963	391	253	285
7	1129	2	300	375	696	264	193	0
2	1125	1	300	205	642	591	697	210
1	1095	3	300	1106	1190	822	792	135
2	1055	4	300	925	1644	468	339	142
3	1131	3	300	202	1142	216	134	134
6	1100	0	300	604	995	964	716	254
5	1086	1	300	677	1232	939	641	380
6	1098	2	300	1388	1598	1344	1041	77
5	1079	1	300	1628	1889	834	473	0
7	1063	3	300	530	665	2296	1875	120
5	1096	6	300	460	516	2390	1590	135
0	1103	3	300	375	917	299	267	387
7	1076	3	300	794	1983	1736	1241	291
8	1050	5	300	1018	1350	340	324	195
3	1121	4	300	195	1004	268	137	454
4	1063	4	300	812	1558	268	163	0
1	1076	1	300	133	831	235	170	157

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H	AMPS	V	TIME	FE	S	SI	AL	CA
				PYRITE				
11	360	2	300	9676	9883	0	15	112
4	360	3	300	10128	10141	0	0	0
4	360	7	300	10049	9821	0	0	249
5	360	3	300	10012	10161	58	0	38
12	360	5	300	10264	10205	16	58	196
5	359	1	300	10276	9931	10	0	0
14	360	1	300	9932	9710	0	0	0
9	361	2	300	9397	9111	66	284	177
7	358	2	300	10045	10222	0	0	233
				DATA				
3	1085	3	300	743	1625	684	471	369
2	1121	2	300	325	1249	1375	520	262
3	1136	3	300	367	1273	598	424	104
7	1107	6	300	351	1442	555	459	13
5	1138	1	300	438	1704	1847	1406	192
7	1113	5	300	925	1472	3937	3274	416
9	1048	2	300	602	938	3540	3283	128
3	1093	3	300	692	1030	738	524	288
5	1139	0	300	498	1148	589	439	455
4	1151	1	300	219	1110	631	317	90
4	1088	2	300	380	1081	741	661	150
5	1139	5	300	1922	2934	462	348	439
4	1143	3	300	418	1139	491	383	231
7	1095	6	300	597	1433	488	383	234
3	1103	2	300	903	1596	469	480	219
2	1086	5	300	1652	1827	855	634	371
5	1006	4	300	5636	4479	1588	1316	0
10	1077	1	300	888	1000	6953	5991	198
11	1095	0	300	2401	2607	6759	5515	383
8	1116	6	300	1043	1324	6093	4381	334
9	1088	1	300	327	1288	2234	1741	365
1	1089	2	300	862	1752	756	520	314
4	1123	2	300	398	1153	1098	306	271
4	1089	3	300	1102	1434	814	591	180
1	1095	7	300	590	1434	1919	1479	200
8	1106	2	300	1254	1575	4722	4007	21
10	1101	5	300	1785	1824	7456	6395	0
9	1096	5	300	2249	2505	4385	3084	198
6	1107	1	300	994	1444	7309	5686	57
10	1124	2	300	752	1225	1956	1554	0
8	1120	3	300	474	1069	3642	3068	166
4	1058	1	300	1023	1180	5689	4873	340
6	1102	1	300	1488	1257	2333	1713	66
4	1135	1	300	380	953	850	617	80
3	1095	6	300	488	1069	792	521	369
3	1048	5	300	547	1094	3808	3200	426
9	1072	3	300	924	1403	6524	5935	390
7	1096	5	300	808	1154	6653	5630	648
3	1100	2	300	572	1120	2163	1670	277
5	1092	9	300	1364	1783	3914	3381	387

H	AMPS	V	TIME	FE	S	SI	AL	CA
3	1085	3	300	1087	1278	5187	4411	73
6	1104	2	300	1053	1508	7493	6220	0
6	1085	10	300	1280	1678	5185	4701	0
5	1136	6	300	615	1147	3209	2613	88
5	1087	4	300	832	1541	3058	2098	20
4	1110	4	300	746	1273	3015	2464	330
8	1125	4	300	665	1305	6000	5297	0
8	1113	3	300	977	1528	5551	4864	111
10	1112	5	300	874	1458	7487	6088	0
6	1093	5	300	2377	1869	6529	5320	0
6	1103	3	300	677	1011	6419	5281	171
8	1093	5	300	1390	1771	7455	6394	480
5	1057	4	300	753	1381	5970	4840	0
7	1059	4	300	1456	1965	7425	6179	310
1	1073	2	300	974	1328	2639	2160	349
2	1112	1	300	448	1354	377	287	251
5	1110	6	300	362	1130	429	309	229
6	1127	0	300	691	1344	1320	1108	579
4	1064	2	300	771	1499	2220	1607	348
9	1028	2	300	1288	1631	5542	4640	332
9	1084	5	300	1066	1619	6497	6128	353
9	1096	5	300	637	939	8271	7423	354
3	1078	3	300	962	1278	6073	3887	0
10	1074	1	300	899	1320	6952	6173	424
7	1096	2	300	794	1328	6944	5663	299
8	1097	3	300	936	1303	8299	6844	0
10	1080	2	300	999	1347	7628	6780	0
9	1088	6	300	1358	1337	6005	4783	292
4	1094	0	300	1086	1595	7708	6466	0
8	1097	2	300	1230	1701	7884	6815	114
9	1087	1	300	654	1277	5118	4765	1308
8	1087	1	300	1634	1956	4367	3497	818
6	1109	7	300	928	1163	6371	5556	73
11	1096	4	300	808	1265	6983	5680	187
5	1033	5	300	587	1471	1825	1584	0
3	1101	2	300	602	1120	2429	1226	292
5	1075	2	300	1035	1600	865	517	267
3	1103	0	300	546	1405	356	224	346
3	1057	3	300	203	794	137	104	213
0	1062	2	300	185	830	259	211	444
0	1107	0	300	698	1407	197	167	59
5	1128	6	300	278	1158	236	116	417
4	1067	6	300	1045	1416	2182	1856	0
9	1116	4	300	738	1302	5438	4450	688
4	1087	6	300	667	1246	7463	6592	0
6	1112	4	300	965	1520	4578	3982	108
8	1078	3	300	461	1212	5670	5015	610
3	1082	1	300	2174	2607	4739	3936	300
8	1062	2	300	751	1115	5299	5051	157
4	1074	1	300	2195	2532	5026	4291	156
3	1075	3	300	1003	1595	3608	2846	28

8	1066	4	300	2677	3234	3474	2852	112
2	1073	0	300	1385	1637	7158	5220	124
4	1059	3	300	1153	1338	8381	6826	0
7	1053	2	300	637	1307	1481	1157	91
7	1117	4	300	935	1400	197	63	126
10	1079	5	300	3818	5013	1614	828	0
3	1120	3	300	242	921	266	205	342
5	1061	5	300	3015	2223	43	76	450
4	1093	3	300	713	1363	766	968	300
7	1139	7	300	713	929	323	282	305
3	1139	6	300	416	1032	241	113	158
7	1101	5	300	499	613	285	147	179
4	1118	1	300	303	710	433	307	181
2	1126	1	300	587	974	393	218	0
3	1116	2	300	375	815	323	137	279
6	1082	6	300	758	1076	6702	5949	259
4	1074	4	300	912	1007	6375	5824	0
4	1091	6	300	595	1202	5467	4664	0
10	1097	2	300	1209	1831	5031	4207	274
7	1094	3	300	1349	1654	6443	5529	267
9	1073	1	300	1098	1597	6192	4976	547
7	1070	8	300	894	1712	5850	4929	3254
2	1105	5	300	1034	1630	2991	2530	211
4	1079	5	300	946	1525	961	937	0
6	1076	5	300	1179	1601	1498	1136	209
7	1089	3	300	512	822	471	242	0
6	1125	4	300	340	1017	502	419	156
5	1112	3	300	282	1165	518	497	342
7	1112	4	300	1081	1221	319	189	357
7	1112	2	300	762	1140	389	220	269

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H	AMPS	V	TIME	FE	S	SI	AL	CA
				PYRITE				
5	366	6	300	10096	10023	0	0	0
5	365	3	300	9649	10333	0	0	154
10	366	3	300	9775	10010	45	95	0
7	366	3	300	10021	10459	0	33	286
16	366	5	300	10201	10236	30	14	0
1	366	2	300	10202	10298	6	0	260
3	366	2	300	10055	10156	0	12	0
3	367	2	300	9647	9412	0	24	0
5	365	5	300	9725	10316	0	0	0
				DATA				
6	1080	2	300	1748	1956	3781	2113	758
4	1102	0	300	2780	2443	6472	4624	222
5	1116	3	300	625	1288	2497	1630	67
3	1087	1	300	474	1251	404	313	86
4	1133	2	300	622	1295	278	311	265
2	1107	2	300	421	1443	853	715	109
5	1150	4	300	640	1584	321	322	449
3	1096	2	300	1981	2147	343	313	0
4	1096	3	300	1096	1715	718	626	0
1	1106	5	300	871	1576	508	526	428
6	1071	5	300	990	1434	600	480	385
4	1054	3	300	2783	2182	897	713	0
2	1074	4	300	1217	1342	765	596	156
2	1111	2	300	801	1437	526	390	0
5	1095	6	300	1204	1564	610	472	102
8	1103	6	300	1162	1326	553	137	494
7	1127	2	300	1264	1544	673	308	486
3	1113	1	300	792	1308	430	240	0
7	1025	4	300	2337	1935	274	203	152
1	1124	5	300	635	1063	163	86	233
10	1079	3	300	313	1235	347	337	0
4	1082	6	300	755	1376	825	443	0
3	1071	3	300	1087	1479	2365	1787	278
3	1105	7	300	1174	1242	1214	810	576
7	1077	4	300	670	1066	900	884	45
4	1119	2	300	1760	1917	806	547	276
1	1137	0	300	719	1160	362	383	37
6	1102	3	300	1312	1948	579	704	547
4	1110	7	300	1816	1653	593	290	37
3	1103	5	300	1079	1590	628	293	358
5	1124	5	300	744	1072	401	226	0
6	1152	3	300	723	1162	605	627	114
4	1090	5	300	1033	1370	361	383	323
5	1047	11	300	1465	1809	543	373	0
6	1070	3	300	1092	1559	1375	1076	72
0	1078	4	300	509	985	797	459	312
11	1111	2	300	815	1327	567	449	216
8	1108	2	300	1420	1447	828	641	169
5	1124	5	300	1291	1507	370	195	322
8	1131	3	300	1183	1421	368	341	322

H	AMPS	V	TIME	FE	S	SI	AL	CA
4	1123	1	300	1028	1372	359	205	95
7	1107	4	300	1125	1558	672	737	157
3	1134	2	300	417	1014	287	304	211
5	1073	4	300	260	736	162	62	30
4	1045	4	300	932	1056	1285	1111	96
3	1137	5	300	690	1201	1118	1016	0
4	853	2	300	1008	1745	375	282	0
3	1150	1	300	1572	1795	931	631	421
4	1141	5	300	1084	1420	754	555	0
4	1140	1	300	1022	1497	566	477	288
3	1142	4	300	637	1329	721	454	133
6	1147	4	300	570	1235	526	369	48
2	1128	7	300	1128	1383	743	525	506
7	1117	1	300	1322	1540	793	604	160
2	1050	3	300	3360	3042	1418	968	26
6	1069	3	300	1691	2032	3510	2215	362
6	1068	0	300	778	1107	1747	1187	229
7	1097	6	300	1922	1779	1415	940	94
5	1135	9	300	1064	1659	907	695	35
5	1123	3	300	354	1180	370	402	308
5	1111	2	300	417	1143	519	406	242
8	1142	4	300	497	1163	348	264	0
8	1105	5	300	1523	1538	820	821	136
1	1136	3	300	749	1432	692	662	286
5	1141	2	300	1175	1763	886	746	168
3	1101	2	300	841	1346	306	213	459
5	1150	2	300	1350	1836	699	475	103
7	1045	1	300	3095	2924	2129	1728	224
6	1125	1	300	2013	2270	1693	1556	0
2	1148	3	300	1055	1644	487	302	47
4	1125	1	300	757	1303	482	391	383
4	1110	5	300	336	1102	412	336	90
5	1126	3	300	649	1195	226	242	348
7	1131	6	300	771	1198	531	495	251
8	1133	2	300	681	1621	748	659	12
7	1103	6	300	869	1633	763	484	87
10	1033	6	300	963	1758	838	501	318
4	1106	3	300	463	1315	397	330	692
3	1102	4	300	217	1508	124	86	447
3	1126	4	300	512	1842	200	189	400
6	1051	5	300	1248	1971	2096	770	365
8	1122	2	300	1008	1986	2178	1492	75
3	1102	4	300	3382	2203	1681	1286	112
5	1139	5	300	1805	1755	1663	1200	0
5	1135	4	300	1191	1483	739	637	173
6	1087	4	300	2850	2730	504	406	0
6	1088	5	300	3492	4361	376	271	0
6	1071	3	300	4953	4412	1583	1446	204
3	1051	1	300	1491	1876	1099	553	195
7	1101	2	300	358	968	1176	832	0
9	1103	2	300	2584	2932	423	349	383

7	1104	6	300	2220	3314	610	514	60
6	1053	4	300	6502	4001	727	478	11
7	1067	1	300	3864	2909	761	594	245
7	1071	2	300	1426	1331	669	453	415
3	1114	4	300	479	1145	512	252	0
2	1114	9	300	375	547	316	145	282
3	1052	1	300	1747	2253	2430	2261	228
6	1135	0	300	906	1878	382	298	396
0	1103	4	300	253	1329	307	303	418
2	1118	4	300	180	1523	251	306	417
5	1145	5	300	79	1665	155	49	389
2	1060	2	300	561	1443	1262	982	318
4	1121	3	300	597	1641	1357	376	164
10	1086	3	300	1811	2234	629	545	259
8	1087	5	300	4323	2300	383	170	284
6	1062	0	300	485	1534	238	108	467
7	1056	7	300	1390	2539	753	511	132
6	1085	1	300	5229	5631	1000	1017	0
6	1137	2	300	845	1355	1132	847	268
2	1142	7	300	312	855	188	166	172
9	1136	1	300	226	634	758	538	127
2	1050	8	300	285	814	221	117	53
8	1129	3	300	950	1367	167	130	47
7	1024	4	300	2253	2003	717	196	314
5	1121	1	300	234	1307	138	181	397
3	1108	6	300	267	1131	204	88	307
1	1098	2	300	809	1161	284	159	97
4	1084	4	300	670	1502	308	121	301
4	1134	1	300	264	999	157	57	147
8	1095	2	300	402	1394	187	91	524

```
308 PASS  40 AREA 7
    H     AMPS      V     TIME      FE        S        SI        AL       CA

                                 PYRITE
    5      366      6      300   10096    10023         0         0        0
    5      365      3      300    9649    10333         0         0      154
   10      366      3      300    9775    10010        45        95        0
    7      366      3      300   10021    10459         0        33      286
   16      366      5      300   10201    10236        30        14        0
    1      366      2      300   10202    10298         6         0      260
    3      366      2      300   10055    10156         0        12        0
    3      367      2      300    9647     9412         0        24        0
    5      365      5      300    9725    10316         0         0        0
                                 DATA
    2     1087      5      300     597      822       254       217      207
    6     1129      5      300     651      886       425       190      197
    2     1083      3      300     490      907       340       267      132
    7     1097      3      300    1227     1350       911       272      187
    9     1092      6      300    3794     4329       178       322      254
    3     1141      5      300     351      955       281       261      135
    3     1087      0      300     434     1324       124       123      360
    6     1067      3      300     406     1037       250       253      373
    4     1066      4      300     802     1541       897       618      282
    7     1102      6      300     739     1712      1075       942      386
    6     1135      4      300     490     1562       316       185      269
    5     1101      7      300     522     1095       691       401      189
    9     1118      7      300     440     1237       135         0      153
    2     1125      2      300     693     1478       647       433       70
    1     1170      3      300     378     1524       850       511        0
    7     1078      6      300     605     1480       826       568      273
   11     1105      3      300    3380     3410       258       370      162
    5     1093      2      300    1295     2062       327       269      350
    5     1114      2      300     535      781       501       448      334
    5     1076      1      300    3062     2624       553       315        0
    5     1134      3      300    1195     1827       443       321      116
    3     1100      5      300     325      732       428       280      202
    0     1082      4      300     433     1218       352       299      475
    1     1104      3      300     463     1032       288       175      362
    6     1125      3      300     682     1236       568       406      391
    8     1125      0      300     333      854       279       232        0
    9     1073      5      300    1017     1374       911       726      243
    7     1086      1      300    1033     1567      2104      1724       15
    3     1136      9      300    1353     1779       553       359      217
    4     1131      2      300    2239     2137       390       382        0
    5     1110      1      300     481     1514       610       463       98
    4     1124      1      300     507     1232       855       480      241
    4     1154      7      300     451     1027      1359       939       80
    5     1071      6      300     651     1345      1676      1564      199
    4     1113      2      300     619     1397       245       172      124
    5     1119      6      300     484      906       304       279      108
    3     1134      8      300     185     1245      2472      1321      160
    4     1106      4      300     659     1514       693       493       33
    7     1078      1      300    1148     2658       851      1261       89
    5     1141      3      300    1285     1642       218       181       83
```

H	AMPS	V	TIME	FE	S	SI	AL	CA
2	1114	2	300	1531	2189	741	587	184
5	1020	1	300	742	1317	2253	1547	153
6	1129	1	300	651	1063	839	670	212
7	1151	6	300	1023	1572	761	625	778
5	1092	8	300	768	1289	360	315	97
5	1050	5	300	3104	2445	476	369	139
5	1076	5	300	1920	1800	962	942	219
8	1049	6	300	928	1379	847	765	254
14	1058	3	300	1739	2522	2154	1720	367
6	1079	0	300	383	1398	966	873	352
5	1114	4	300	280	1373	379	262	0
7	1119	5	300	1759	5213	287	2163	425
4	1149	2	300	310	1207	356	314	0
4	1122	4	300	716	1297	1675	782	6
3	1119	4	300	205	617	120	25	141
3	1071	4	300	461	1062	305	225	162
5	1127	2	300	1094	1647	540	511	55
6	1096	3	300	452	1372	235	200	209
4	1100	1	300	704	1151	614	400	209
7	1109	0	300	469	1544	373	350	48
6	1140	4	300	576	1680	393	440	163
3	1117	1	300	394	1267	143	182	108
5	1103	2	300	581	2054	482	333	1750
2	1108	3	300	363	1326	581	407	527
5	1081	4	300	1146	1649	398	271	194
10	1121	5	300	902	1557	378	413	244
6	1122	5	300	978	1203	1042	280	0
5	1090	1	300	2304	2857	478	331	320
5	1105	2	300	1673	2611	168	91	109
7	1091	5	300	4268	3734	978	679	1427
7	1096	7	300	3213	4112	585	1212	156
2	1068	3	300	1279	1767	471	336	0
7	1085	2	300	664	1569	783	453	87
0	1126	3	300	683	1519	416	94	96
5	1111	3	300	538	1330	349	308	793
4	1126	3	300	909	1283	176	119	320
2	1075	3	300	417	846	280	173	224
5	1085	5	300	584	1336	268	307	172
4	1100	4	300	265	834	179	138	115
6	1092	4	300	1057	1734	361	334	83
3	1132	2	300	632	1674	412	347	270
3	1120	6	300	511	1022	488	312	103
4	1112	12	300	785	1501	266	264	407
4	1086	3	300	675	1635	326	287	70
0	1070	1	300	967	2454	607	1186	398
5	1095	5	300	1678	3701	734	1913	0
7	1099	1	300	1164	1718	308	249	124
4	1103	3	300	683	1562	208	145	0
2	1142	2	300	0	1201	190	194	60
7	1139	6	300	1386	2103	290	292	273
5	1167	2	300	194	1233	165	90	124

6	1071	10	300	2937	3760	372	248	167
8	1084	2	300	1408	3163	916	825	116
2	1148	1	300	770	2175	387	591	248
4	1101	6	300	1503	2673	985	1379	405
8	1074	4	300	877	1820	694	635	244
4	1098	6	300	1016	1327	975	830	0
6	1085	4	300	660	1573	458	366	275
8	1108	4	300	1438	1527	465	171	151
6	1091	3	300	765	1492	1364	1027	559
8	1106	3	300	2265	2146	726	550	0
5	1047	4	300	2414	2810	969	819	410
4	1127	5	300	1353	1712	498	357	366
3	1111	3	300	423	880	198	137	180
5	1084	2	300	1313	1270	649	414	109
4	1094	1	300	984	1525	1925	1336	216
3	1076	5	300	3004	2892	797	558	117
9	1122	3	300	1015	1956	157	144	134
7	1148	4	300	356	1340	435	358	236
3	1133	4	300	1977	2249	455	360	352
4	1079	3	300	2258	2535	853	804	0
9	1109	4	300	1456	1843	374	412	388
2	1141	5	300	436	1324	322	217	106
2	1066	2	300	1666	2393	418	532	237
6	1116	2	300	1160	1921	157	129	0
3	1142	2	300	531	1513	421	277	0
5	1062	2	300	867	1437	4834	4107	278
2	1072	0	300	276	903	592	524	190
3	1114	4	300	458	849	383	181	504
7	1122	0	300	1554	1668	2186	1794	204
2	1154	7	300	2416	2621	890	810	40

308 PASS 40 AREA 8

H	AMPS	V	TIME	FE	S	SI	AL	CA
				PYRITE				
8	359	9	300	9375	10501	0	0	0
4	358	3	300	9746	10604	0	0	297
6	359	4	300	10362	10080	12	0	27
10	359	3	300	9915	10344	0	0	0
4	358	9	300	9524	9648	0	0	76
7	359	3	300	9820	9974	142	68	0
4	360	6	300	8977	9730	0	0	103
8	360	6	300	9205	9278	0	123	193
6	358	1	300	9788	10053	72	0	43
				DATA				
2	1066	4	300	476	1053	717	714	6
8	1139	2	300	269	1217	382	210	162
1	1138	11	300	351	990	123	0	0
6	1087	3	300	710	1147	742	301	42
4	1097	3	300	319	1013	1365	1118	74
4	1116	2	300	506	1270	2036	1826	0
7	1078	3	300	684	1441	1387	1353	140
6	1103	3	300	318	1306	270	218	48
13	1094	3	300	769	1582	686	545	240
6	1104	2	300	394	1150	458	309	122
4	1121	2	300	259	919	248	146	144
1	1123	4	300	345	1086	266	182	303
6	1093	3	300	170	921	115	167	262
3	1147	6	300	336	1097	158	104	202
5	1148	2	300	0	859	209	162	262
7	1095	6	300	350	999	335	280	374
5	1107	4	300	354	1008	233	159	224
4	1068	3	300	750	1282	3070	1878	150
11	1137	2	300	360	1150	2237	1789	0
8	1081	3	300	400	1171	779	539	201
4	1145	2	300	251	963	234	56	34
8	1134	6	300	152	927	125	135	127
4	1166	7	300	221	1120	313	168	296
5	1063	2	300	465	927	153	61	33
4	1086	7	300	588	1332	245	148	224
3	1091	1	300	556	1234	236	166	0
6	1106	12	300	311	1311	339	336	278
4	1097	1	300	367	1114	2345	1785	417
4	1091	2	300	376	1077	2308	1877	308
4	1127	1	300	324	920	255	293	240
6	1132	5	300	443	1210	330	222	211
2	1088	2	300	95	876	108	81	145
5	1108	5	300	116	708	196	208	679
5	1130	7	300	678	1260	209	154	0
7	1114	4	300	1323	1519	446	177	231
2	1144	2	300	140	848	204	75	426
7	1117	4	300	701	1191	97	83	302
5	1130	2	300	290	1115	186	118	311
7	1117	6	300	176	1350	181	234	0
2	1173	8	300	132	1069	1177	1129	122

H	AMPS	V	TIME	FE	S	SI	AL	CA
5	1114	3	300	218	1224	458	314	337
4	1095	4	300	471	1448	620	456	264
4	1067	4	300	744	971	663	431	118
3	1090	4	300	536	1121	178	176	36
6	1121	1	300	640	1052	426	167	223
5	1090	5	300	241	601	131	111	125
0	1112	0	300	41	442	286	75	336
6	1018	4	300	355	625	232	83	292
8	1096	2	300	330	1039	579	458	263
6	1090	3	300	833	1244	486	442	297
4	1120	3	300	97	1031	558	503	89
7	1115	3	300	194	943	1000	837	316
4	1123	4	300	535	1294	389	378	120
6	1124	6	300	1196	1818	577	430	491
2	1157	4	300	573	998	45	157	47
5	1089	3	300	1321	1354	580	257	110
4	1098	3	300	387	1287	373	295	352
6	1160	5	300	223	836	238	87	100
4	1101	4	300	335	831	236	212	209
3	1113	4	300	355	850	511	414	248
4	1088	3	300	278	1104	288	205	367
3	1125	0	300	368	1006	111	187	323
4	1121	9	300	268	1003	416	415	426
4	1080	3	300	787	1336	1363	1009	240
9	1086	2	300	353	875	359	404	46
4	1103	5	300	119	645	269	259	0
3	1113	4	300	662	893	237	198	122
7	1030	4	300	1184	1714	727	543	200
5	1077	3	300	353	1236	154	113	0
5	1134	2	300	109	1380	231	85	36
5	1075	6	300	323	1345	516	378	192
5	1131	3	300	1252	1678	166	143	325
8	1092	2	300	1023	1713	268	201	357
4	1065	2	300	819	1286	329	150	0
3	1131	5	300	27	978	366	165	226
6	1124	5	300	159	922	277	265	385
1	1142	2	300	292	831	153	171	234
5	1078	6	300	580	1214	977	667	464
8	1099	2	300	684	1115	2019	1805	367
4	1092	2	300	905	1694	637	426	87
4	1144	2	300	304	982	414	305	192
4	1110	3	300	522	1077	238	260	309
10	1025	7	300	16948	1862	1203	879	199
8	1104	6	300	1850	1251	855	489	292
9	1094	3	300	1405	1561	346	114	67
9	1116	4	300	548	1440	184	120	363
3	1093	3	300	83	1212	99	50	0
4	1095	3	300	455	1508	148	124	148
4	1121	6	300	303	1167	141	201	75
6	1027	5	300	225	1134	210	110	97
5	1095	4	300	340	1383	321	241	616

```
       6      1109         3       300      1149      1852       372       296        77
       5      1086         5       300      1145      1277       468       246       330
       5      1120         1       300       501      1317       321       222       138
       8      1118         3       300      3968      1128       467       388       175
      20      1080         3       300     10927      2105       329       232       484
       4      1079         5       300      3501      1329      1416      1159       217
       5      1099         1       300      1109      1334      2843      2083        44
       6      1115         4       300      1140      1120      2921      2325       141
       6      1105         6       300       397       922      1314       869       315
       4      1082         0       300       834      1549       561       395       286
       5      1110         5       300      1264      1560      2270      1890         0
       2      1130         3       300       640       990      1874      1643       133
       3      1066         1       300       388      1030      1666      1554         0
       4      1103         3       300      1136      1562       868       640       194
       7      1089         2       300       882      1092      1638      1115       113
       1      1074         2       300       656      1062       439       321       248
       2      1078         6       300       746      1255       846       321       304
       5      1052         3       300       563      1222       277        55       290
       8      1065         1       300       668      1270      1557      1565       254
       2      1118         1       300       398      1092       359       331       163
       4      1090         4       300      1244      2041      1481      1192        48
       6      1131         3       300      1039      1554       370       253       179
       7      1180         2       300       300      1285       409       251       275
       4      1163         3       300       188       995       259       182       460
       5      1166         4       300       277      1047        72        73       281
       6      1102         3       300       380       797       244       254         0
       4      1082         3       300      3170      3342       975      1152        94
       7      1069         2       300      1378      2685      2174      2557      1710
       1      1108         4       300       725      1285      3423      2606         0
       3      1113         3       300       800      1166      2920      2623       123
STOP --
```

APPENDIX D

CORRELATIONS AND EIGEVECTORS FOR EPA- SUPPLIED COALS

```
1632A FG 2000X                   3235.DAT

                              CORRELATIONS

       MEAN      SIGMA     FE       S        SI       AL       CA

FE     1.0293   0.4023   1.0000   0.5605   0.2181   0.2280  -0.0498
S      1.5890   0.3365   0.5605   1.0000   0.0411   0.0409   0.0224
SI    10.3755   1.3600   0.2181   0.0411   1.0000   0.3841  -0.0224
AL     4.9257   0.4769   0.2280   0.0409   0.3841   1.0000   0.0675
CA     1.3249   0.5945  -0.0498   0.0224  -0.0224   0.0675   1.0000

EIGENVECTORS

  VALUE       FE        S         SI        AL        CA
   1.7595    0.6213    0.5042    0.4215    0.4268   -0.0004
   1.2245   -0.3030   -0.5447    0.5389    0.5526    0.1253
   1.0119   -0.0279    0.1292   -0.1670    0.0537    0.9756
   0.6065    0.0435   -0.0519   -0.7028    0.6920   -0.1503
   0.3975   -0.7208    0.6555    0.1008    0.1752   -0.0998

    REGRESSIONS


S  =  2.0229 +  0.9045FE + -0.2771AL
FE(CLAY) =  1.5090  FE(PYRT) = -0.4797

ORGANIC S=      1.589  MINERAL S=      0.000
```

```
1635 FG 2000X                    3236.DAT

                           CORRELATIONS

      MEAN      SIGMA     FE        S         SI        AL        CA

FE    0.4094    0.2272    1.0000    0.0178   -0.0277    0.0149    0.0766
S     0.6606    0.1737    0.0178    1.0000   -0.0726   -0.0370    0.0057
SI    1.5514    0.9734   -0.0277   -0.0726    1.0000    0.0012    0.0063
AL    0.5342    0.1971    0.0149   -0.0370    0.0012    1.0000    0.1260
CA    3.4723    0.6153    0.0766    0.0057    0.0063    0.1260    1.0000

EIGENVECTORS

 VALUE       FE         S          SI         AL         CA
  1.1552     0.3885    -0.0753    -0.0016     0.6115     0.6852
  1.0893     0.3350     0.6645    -0.6436    -0.1749     0.0377
  0.9709    -0.7805     0.1612    -0.3678     0.4780     0.0328
  0.9334    -0.1993     0.6871     0.6429    -0.0804     0.2617
  0.8511    -0.2966    -0.2338    -0.1930    -0.6005     0.6779

   REGRESSIONS

S  =  1.0583 + -0.0317CA + -0.1854SI

ORGANIC S=       0.661  MINERAL S=      0.000
```

```
PHS 408 FG 2000X                 3237.DAT

                              CORRELATIONS

        MEAN      SIGMA     FE        S         SI        AL        CA

 FE    0.6712    0.2935   1.0000  -0.0432  -0.0023   0.0600   0.0302
 S     1.5243    0.2964  -0.0432   1.0000   0.0302  -0.0417   0.5610
 SI    4.7923    1.2726  -0.0023   0.0302   1.0000   0.5267   0.0812
 AL    1.6665    0.3026   0.0600  -0.0417   0.5267   1.0000   0.0228
 CA    3.3401    1.0729   0.0302   0.5610   0.0812   0.0228   1.0000

EIGENVECTORS

  VALUE        FE          S          SI          AL          CA
   1.5970     0.0260     0.5557     0.4396     0.3744     0.5976
   1.5017     0.0851    -0.4408     0.5452     0.6023    -0.3722
   1.0039     0.9889    -0.0351    -0.1190    -0.0072     0.0818
   0.4661    -0.0876    -0.0100    -0.7035     0.6991     0.0926
   0.4314    -0.0809    -0.7040     0.0216    -0.0912     0.6994

   REGRESSIONS

S  =  0.7856 + -0.1110AL +  0.2765CA

ORGANIC S=       0.786  MINERAL S=       0.739
```

```
PHS 506 FG 2000X                      3238.DAT
                                  CORRELATIONS
        MEAN      SIGMA      FE        S        SI        AL        CA
FE     1.3164    0.5878   1.0000    0.6880  -0.0301   -0.0626    0.1237
S      1.9644    0.5540   0.6880    1.0000   0.0111    0.0811    0.1246
SI     4.1851    0.3815  -0.0301    0.0111   1.0000    0.4660   -0.1274
AL     3.0753    0.3193  -0.0626    0.0811   0.4660    1.0000   -0.0106
CA     1.5400    0.6117   0.1237    0.1246  -0.1274   -0.0106    1.0000

EIGENVECTORS

 VALUE       FE          S         SI         AL         CA
  1.7336    0.6851     0.6784    -0.0879    -0.0429     0.2467
  1.4880    0.0395     0.1476     0.6952     0.6865    -0.1487
  0.9550   -0.1907    -0.1342    -0.0049     0.2484     0.9402
  0.5298   -0.1391     0.1560    -0.7068     0.6509    -0.1816
  0.2937   -0.6880     0.6897     0.0966    -0.2037     0.0132

   REGRESSIONS


S  = -0.2305 +  0.9520FE +  0.2250SI
FE(CLAY) =  0.0000  FE(PYRT) =  1.3164

ORGANIC S=       0.000  MINERAL S=      1.964
```

```
PHS 534 FG 2000X                    3239.DAT

                              CORRELATIONS

       MEAN      SIGMA     FE        S         SI        AL        CA

FE     2.3614    1.6575    1.0000    0.9683    0.0938    0.1196   -0.0723
S      3.1607    1.7882    0.9683    1.0000    0.0676    0.0958   -0.0523
SI     8.6834    1.0559    0.0938    0.0676    1.0000    0.6537    0.2111
AL     5.4745    0.6211    0.1196    0.0958    0.6537    1.0000    0.2423
CA     0.6820    0.4368   -0.0723   -0.0523    0.2111    0.2423    1.0000

EIGENVECTORS

  VALUE        FE          S           SI          AL          CA
  2.0606      0.6289      0.6215      0.3163      0.3372      0.0665
  1.7142     -0.3096     -0.3214      0.5634      0.5603      0.4115
  0.8495      0.0769      0.1162     -0.3113     -0.2445      0.9077
  0.3448     -0.0151     -0.0139     -0.6967      0.7158     -0.0430
  0.0309     -0.7088      0.7048      0.0156      0.0127     -0.0214

    REGRESSIONS


S  =  0.9491 +  1.0785FE + -0.0612AL
FE(CLAY) =  0.3107  FE(PYRT) =  2.0507

ORGANIC S=       0.949  MINERAL S=      2.212
```

```
PHS 546 FG 2000X                    3240.DAT

                              CORRELATIONS
        MEAN      SIGMA     FE        S         SI        AL        CA
FE    1.5530    0.7185    1.0000    0.8753    0.0018    0.0553   -0.1117
S     3.6031    0.7851    0.8753    1.0000   -0.1050    0.0296   -0.1411
SI    8.8520    1.0551    0.0018   -0.1050    1.0000    0.2627    0.1305
AL    4.8227    0.3774    0.0553    0.0296    0.2627    1.0000    0.1283
CA    0.6327    0.4594   -0.1117   -0.1411    0.1305    0.1283    1.0000

EIGENVECTORS

 VALUE       FE          S           SI          AL          CA
 1.9208    0.6836     0.6931     -0.1051      0.0050     -0.2033
 1.3469    0.1439     0.0660      0.6246      0.6504      0.4023
 0.8829    0.0922     0.1167     -0.3626     -0.2343      0.8896
 0.7313   -0.1115    -0.0192     -0.6782      0.7225     -0.0721
 0.1180   -0.7008     0.7080      0.0860     -0.0073      0.0129

    REGRESSIONS

S  =  3.1161 +  1.1089FE + -0.2561AL
FE(CLAY) =  1.1138  FE(PYRT) =  0.4392

ORGANIC S=       3.116  MINERAL S=       0.487
```

```
PHS 578 FG 2000X                3241.DAT

                           CORRELATIONS

      MEAN      SIGMA     FE        S         SI        AL        CA

 FE   2.2319   0.8378   1.0000   0.8667  -0.1013  -0.0751  -0.1215
 S    6.3396   0.8477   0.8667   1.0000  -0.1565  -0.1159  -0.1610
 SI   6.3561   1.0952  -0.1013  -0.1565   1.0000   0.2484  -0.0364
 AL   3.0251   0.2940  -0.0751  -0.1159   0.2484   1.0000  -0.1615
 CA   2.4743   1.0061  -0.1215  -0.1610  -0.0364  -0.1615   1.0000

EIGENVECTORS

  VALUE       FE          S          SI          AL          CA
   1.9650    0.6645     0.6781    -0.2152     -0.1615     -0.1617
   1.2974    0.1170     0.0864     0.5278      0.6583     -0.5167
   0.8922    0.2339     0.1491     0.6084      0.0341      0.7428
   0.7158   -0.0601    -0.0344     0.5508     -0.7338     -0.3916
   0.1297   -0.6974     0.7136     0.0400      0.0313      0.0421

   REGRESSIONS


S  =  4.4801 +  1.0207FE + -0.1384AL
FE(CLAY) =  0.4101  FE(PYRT) =  1.8218

ORGANIC S=      4.480  MINERAL S=      1.859
```

APPENDIX E

DESCRIPTION OF COMPUTER PROGRAMS

The computer programs for the MASC analysis and MAPS analysis are variations of a single program and will be discussed in this appendix. A source listing for the programs will be available from the authors upon request.

The program can be divided into three logical units: (1) input-output and normalization, (2) stoichiometric analysis and multivariate analysis, and (3) particle size fitting.

The first section of the program accepts the data which was encoded on mass storage files by the scanning electron microprobe control programs. The data for each element analyzed by the microprobe can be normalized in a variety of ways. The data is normalized to unit microprobe current. The first nine points of each data set are taken on a pure pyrite sample and the average of these points is used to reduce the iron and sulfur data to k-ratios. A correction for the effectiveness of the pyrite standard signal relative to a zero density pyrite standard is either applied to the raw data or alternatively to the output of the programs. Plots of sulfur versus iron (or other combinations of elements) are generated. The main program has provisions for several different kinds of cuts to the data set. Backgrounds of several kinds (dark currents, dispersed distributions, etc) may be subtracted from each element, particularly iron and sulfur. An ellipse respresenting any given concentration (standard deviation) is computed from the data means and correlation for the bivariate distribution of sulfur and iron and the ellipse is plotted on the data set. For the purposes of the MAPS particle size analysis fits, data points representing large pyrite rocks, lying outside of a 2.0 or 3.0 standard deviation ellipse are discarded. This also eliminates points which are extraneous glitches in the data as sometimes occur. The results of the correlation analysis (elemental means and standard deviations, bivariate and multivariate correlation coefficients, pyrite stoichiometry, and organic sulfur content), are recorded in tabular form on mass storage for later analysis and review.

The correlation phase of the programs takes the normalized data vectors prepared in section one and computes means, standard deviations, bivariate correlations, etc. A multivariate components analysis (Ref. 1) is applied to multielement data sets to separate the pyrite, clay and organic contributions to the various elements by calculating the eigenvalues and eigenvectors of the correlation matrix.

The third major subdivision of the program implements the MAPS particle size analysis. The data vector for iron and sulfur are binned in a given number of bins and the resulting histogram data distributions plotted. The least square fitting subroutine is called with either the iron, sulfur or iron and sulfur data distributions as input. In the present analysis, each data bin is weighted equally but there is provision in the program for different weights for each point. A generalized least squares fitting procedure yields multiparameter fits of a functional form, here Ψ (S) as given in Eq. II-4, to the data base. The residual from the fit is computed and the results plotted along with the data histograms.